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PART II

Statutory Notifications (S.R.O)

GOVERNMENT OF PAKISTAN

OIL AND GAS REGULATORY AUTHORITY

NOTIFICATION

Islamabad, the 24th September, 2009

S.R.O. 819(I)/2009.-In exercise of the powers conferred by Section 42 of Oil and Gas Regulatory Authority Ordinance, 2002 (Ordinance XVII of 2002) the Oil and Gas Regulatory Authority is pleased to make the following regulations namely:-

1. Short title and Commencement:- (1) These Regulations may be called the Technical Standards for Oil Refineries.

(2) They shall, come into force at once.

2. Applicability:- These regulations shall be applicable to all industrial plants where crude oil is processed and includes all other ancillary facilities as required for the purpose.

3. Definition:- (1) In these regulations, unless there is anything repugnant in the subject or context:-

(i) ACI: American Concrete Institute

(ii) AECL: Atomic Energy of Canada Limited

(iii) AGA: American Gas Association

(iv)	AGMA:	American Gear Manufacturers Association
(v)	ANSI:	American National Standards Institute
(vi)	API:	American Petroleum Institute
(vii)	ASCE:	American Society of Civil Engineers
(viii)	ASHRAE:	American Society of Heating, Refrigerating, and Air-Conditioning Engineers
(ix)	ASME:	American Society of Mechanical Engineers
(x)	ASSE:	American Society of Safety Engineers
(xi)	ASTM:	ASTM International
(xii)	AWS:	American Welding Society
(xiii)	BS:	British Standards Institution
(xiv)	ULC:	Underwriters Laboratories of Canada
(xv)	CFR:	Code of Federal Regulations
(xvi)	CGA:	Compressed Gas Association
(xvii)	DIN:	Deutsches Institute Fur Normung E.V. (German National Standard)
(xviii)	ESA:	European Space Agency
(xix)	FCI:	Fluid Controls Institute
(xx)	GPA:	Gas Processors Association
(xxi)	IEC:	International Electrotechnical Commission
(xxii)	IEEE:	Institute of Electrical and Electronics Engineers
(xxiii)	ISO:	International Organization for Standardization
(xxiv)	MSS:	Manufacturers Standardization Society
(xxv)	NACE:	National Association of Corrosion Engineers
(xxvi)	NEMA:	National Electrical Manufacturers Association
(xxvii)	NFPA:	National Fire Protection Association
(xxviii)	PIP:	Process Industry Practices
(xxix)	SME:	Society of Manufacturing Engineers
(xxx)	TMS:	The Masonry Society
(xxxi)	UL:	Underwriters Laboratories
(xxxii)	ULC:	Underwriters Laboratories of Canada

4. Foreword

“Technical Standards for Oil Refineries” have been developed, in order to facilitate the mid stream oil sector in Pakistan. In preparation of this document a wide base of

current industry experience, knowledge, information, and management practices regarding application of technical standards has been gathered and consolidated these into a cohesive document addressing technical and safety concerns of oil industry. The technical standards lay a guideline for application to oil refineries in design, material, construction, assembly, inspection, testing, maintenance and safety of facilities.

The Oil and Gas Regulatory Authority in accordance with the sub sections (d), (e) and (f) of Section 6(2) and Section 42(2)(b) of the OGRA Ordinance, 2002 is required to:

- administer, enforce and certify standards and other conditions for undertaking any regulated activity so specified;
- in consultation with licensees specify and review standards for the equipment and materials to be used in undertaking any regulated activity;
- promote and ensure the observance of efficient practices, where applicable, in the transmission, distribution, processing, refining, marketing, storage of petroleum and transportation of petroleum by pipelines; and
- establish technical standards and their monitoring for the design, construction, testing, operation, maintenance and abandonment of a regulated activity;

Keeping in view the above, these “Technical Standards for Oil Refineries” have been made to adhere to the safety which is of paramount importance in the oil refinery. This document consists of fifteen sections which interalia cover the fire protection facilities, pressure relieving devices, above ground atmospheric and low pressure petroleum storage tanks, underground storage tanks, LPG storage facilities, compressors, pumps, Heaters, heater exchangers, vessels, pipelines and piping, mechanical, electrical, instrumentation and civil.

This document includes a wide range of internationally accepted standards; however, other compatible standards may be used where necessary with a prior approval of OGRA. Similarly, relaxation in application of these standards can only be allowed by the Authority on submission of specific requests by the refineries giving ample justification justifying the relaxation sought. The Authority shall consider allowing these relaxations in line with best industry practices and, if required, taking all stakeholders on board.

The applicability of these standards to facilities, equipments and construction or installations already in place or in the process of construction/installation before the enforcement of this document is to be evaluated by the Authority on case to case basis, considering the circumstances and site conditions ensuring adherence to these standards or documented compatibility with standards already prevalent in the industry. In addition, the licensees may refer matter to OGRA for interpretation of these standards as and where necessary. Whereas, the intended application of these standards is given below in the sub-head “scope”, it remains the responsibility of the users of these standards to judge the suitability for particular purpose.

5. Scope

“Technical Standards for Oil Refineries” cover the design, material, construction, assembly, inspection, testing, maintenance and safety of facilities. The refiners are required to fully consider the requirements of the particular applications and circumstances that may exist and appropriately apply the recommended technical standards stipulated in this document. These technical standards address the safety concerns associated with it and it shall remain the continuing responsibility of the refinery to establish appropriate safety and health practices and comply with the necessary limitations and compulsions interconnected with its use.

6. Removal of Difficulty:-

The industry may refer any problem faced by them in implementing these technical standards to Authority for its consideration. The Authority’s decision on the referred issues would be final.

Chapter-1

7. Fire Protection Facilities

(1)	**Standard:**	API RP 500
	Title:	Recommended Practice for Classification of Locations for Electrical Installations at Petroleum Facilities Classified as Class I, Division I and Division 2
	Description:	This recommended practice provides guidelines for determining the degree and extent of Class I, Division 1 and Class I, Division 2 locations at petroleum facilities, for the selection and installation of electrical equipment. Basic definitions provided in the "National Electric Code" have been followed in developing this document which applies to the classification of locations for both temporarily and permanently installed electrical equipment. RP 500 is intended to be applied where there may be a risk of ignition due to the presence of flammable gas or vapor, mixed with air under normal atmospheric conditions
(2)	**Standard:**	API RP 505
	Title:	Recommended Practice for Classification of Locations for Electrical Installations at Petroleum Facilities Classified as Class I, Zone 0, and Zone 2
	Description:	This recommended practice provides guidelines for determining the degree and extent of Class I, Zone 0, Zone 1, and Zone 2 locations at petroleum facilities, for the selection and installation

of electrical equipment. Basic definitions provided in the "National Electrical Code" have been followed in developing this document which applies to the classification of locations for both temporarily and permanently installed electrical equipment. RP 505 is intended to be applied where there may be a risk of ignition due to the presence of flammable gas or vapor, mixed with air under normal atmospheric conditions.

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(3) **Standard:** API 750
Title Management of Process Hazards
Description: This recommended practice is intended to assist in the management of process hazards. The objective of this publication is to help prevent the occurrence of, or minimize the consequences of, catastrophic releases of toxic or explosive materials. This recommended practice addresses the management of process hazards in design, construction, start-up, operation, inspection, maintenance, and modification of facilities with the potential for catastrophic release.

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(4) **Standard:** API RP 752
Title Management of Hazards Associated With Location of Process Plant Buildings,
Description: This recommended practice provides guidance for identifying hazards that may affect plant buildings. It also provides guidance for those managing risks related to those hazards. It focuses on refineries, petrochemical and chemical operations, natural gas liquids, extraction plants, and other facilities covered by the OSHA Process Management Standard, 29 CFR 1910.119.

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(5) **Standard:** API RP 2001
Title Fire Protection in Refineries
Description: This recommended practice covers basic concepts of refinery fire protection. It reviews the chemistry and physics of refinery fires; discusses how the design of refinery systems and infrastructure impact the probability and consequences of potential fires; describes fire control and extinguishing systems typically used in refineries; examines fire protection concepts that should be covered in operating and maintenance practices and procedures; and provides information on organization of and training for refinery emergency responders.

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(6) **Standard:** API RP 2021 (R2006)
Title Management of Atmospheric Storage Tank Fires
Description: This recommended practice provides experience-based

		information to enhance the understanding of fires in atmospheric storage tanks containing flammable and combustible materials. It presents a systematic management approach which can assist tank fire prevention. If fires do occur, this information can help responders optimize fire suppression techniques to reduce the severity of an incident and reduce the potential for escalation.
(7)	**Standard:**	API Publ 2218
	Title	Fireproofing Practices in Petroleum & Petrochemical Processing Plants
	Description:	This standard is intended to provide guidelines for selecting, applying, and maintaining fire proofing materials that are designed to limit the extent of fire-related property loss in the petroleum and petrochemical industries.
(8)	**Standard:**	NFPA 10
	Title	Portable Fire Extinguishers
	Description:	Portable fire extinguishers are an important first line of defense against small fires. For maximum protection, be sure to select and maintain equipment using the provisions in NFPA 10: Standard for Portable Fire Extinguishers. This document covers equipment distribution, placement, maintenance, operation, and inspection--as well as testing and recharging.
(9)	**Standard:**	NFPA 11
	Title	Standard for Low-, Medium-, and High-Expansion Foam
	Description:	NFPA 11 covers all aspects of the design, installation, operation, testing, and maintenance of low-, medium-, and high-expansion foam systems for fire protection. Criteria apply to fixed, semi-fixed, or portable systems for interior and exterior hazards.
(10)	**Standard:**	NFPA 12
	Title	Standard on Carbon Dioxide Extinguishing Systems
	Description:	The Standard is prepared for the use and guidance of those who purchase, design, install, test, inspect, approve, list, operate or maintain carbon dioxide fire extinguishing system equipment. Coverage addresses total flooding systems, local application systems, hand hose line systems, standpipe systems, and mobile supplies. This standard also contains important clarifications of the requirements for personnel safety features, which must be incorporated in every carbon dioxide fire extinguishing system.
(11)	**Standard:**	NFPA 12A
	Title	Standard on Halon 1301 Fire Extinguishing Systems

	Description:	This standard gives guidelines for safety requirements for designing, installing, testing, inspecting, approving, listing, operating, maintaining, decommissioning, and removing Halon systems.
(12)	**Standard:**	NFPA 13
	Title	Installation of Sprinkler Systems
	Description:	This standard provides the rules for all aspects of automatic sprinkler system design and installation. It also covers the character and adequacy of water supplies and the selection of sprinklers, piping, and valves.
	Related standard:	NFPA 13HB - Automatic Sprinkler Systems Handbook, NFPA 13 Tabs - Designer's Guide to Automatic Sprinkler Systems
(13)	**Standard:**	NFPA 14
	Title	Standard for the Installation of Standpipe, Private Hydrants, and Hose Systems
	Description:	This standard gives the guidelines regarding installation of standpoint and hose systems *interalia* covering guidelines for spacing and location of fire hose valves, use of pressure reducing devices in multi-zone standpipe systems and roof outlet applications.
(14)	**Standard:**	NFPA 15
	Title	Standard for Water Spray Fixed Systems for Fire Protection
	Description:	Up-to-date with current technology, engineering principles, test data, and field experience, NFPA 15 covers the design, installation, maintenance, and test requirements for fixed water spray systems for fire protection. Also included in this document are minimum requirements for the periodic testing and maintenance of ultra high-speed fixed water spray systems.
(15)	**Standard:**	NFPA 16
	Title:	Standard for the Installation of Foam-Water Sprinkler and Foam-Water Spray Systems

Description: NFPA 16 outlines requirements for the design, installation, and maintenance of foam-water sprinkler and spray systems. Systems are to be designed with the required density for either foam or water application as the controlling factor, depending on the design purpose of the system. This standard covers:

- System components;
- Water supplies ;
- System design and installation ;
- Acceptance tests; and
- Inspection, testing, and maintenance.

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(16) **Standard:** NFPA 20

Title Installation of Stationary Pumps for Fire Protection

Description: NFPA 20 ensures that stationary fire pumps can deliver on cue and is reliable for fire protection. It keeps up with advancements in fire protection system technology. This Standard is a complete source for comprehensive guidance on stationary fire pumps including:

- Fire pump design;
- Electrical and mechanical construction;
- Testing; and
- Operation.

With broader coverage and additional information, it also includes:

- Information on variable speed drive applications;
- Calculation methods for pressure relief valves and test header piping; and
- Applications for pressure reducing valves.

Related standard: NFPA 20HB07 - Handbook for Stationary Fire Pumps.

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(17) **Standard:** NFPA 30

Title: Flammable and Combustible Liquids Code

Description: NFPA 30 facilitates consistency and correlation with major construction and fire codes. This Flammable and Combustible Liquids Code presents the latest and most complete guidance on the safe storage, handling, and use of these volatile substances. It provides the criteria needed to design facilities for better protection, comply with sprinkler requirements, and use safe operating practices. It also includes:

- Introduction of the concepts of control area, maximum allowable quantities, and protection levels;
- Additional fire protection design criteria for warehouse storage of containers, intermediate bulk containers, and portable tanks; and
- Expanded requirement for overfill prevention measures to comply with EPA SPCC (Spill Prevention, Control and Countermeasures) guidelines.

Related standard: NFPA 30HB08 - Flammable and Combustible Liquids Code Handbook.

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(18) **Standard:** NFPA 45
Title Standard on Fire Protection for Laboratories Using Chemicals

Description: NFPA 45 Ensure the fire safe design and operation of instructional, educational, and industrial laboratories using chemicals. This document outlines the maximum allowable quantities of liquids and gases, as well as requirements for laboratory ventilating systems and chemical fume hoods. This standards includes:

- New requirement for all new laboratories to have an automatic fire extinguishing system;
- Clarification of the scope that labs containing either the minimum quantity of flammable and combustible liquids or gas would qualify the lab for coverage under NFPA 45;
- Requirements defining and regulating pressurized liquid dispensing containers;
- Expanded advisory material on biological safety cabinets and recognition of listed Class II, Type B2 biological safety cabinets in lieu of chemical fume hoods under certain circumstances;
- Clarification of requirements for liquid dispensing;
- Expanded requirements and advisory information for compressed and liquefied gases; and
- Maximum quantity requirements are clarified for outside cylinder storage.

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(19) **Standard:** NFPA 1961
Title: Standard on Fire Hose
Description: Fire hoses are essential tools. NFPA 1961 presents the minimum requirements for the design and construction of fire hose and the design verification testing done by the manufacturer of new fire

hose. This document for fire hose applies to:

- Attack hose used by trained firefighters and fire brigade members in regular fire fighting operations;
- Forestry hose used in wild land fire suppression;
- Supply hose (large diameter hose) used to convey water from its source to fire apparatus at a fire scene; and
- Suction hose used to get water into a pump when the water must be pumped from a static source such as a lake or river.

(20) Other relevant standards are:

Standard:	NFPA 24
Title	Installation of Private Fire Service Mains and their Appurtenances
Standard:	NFPA 780
Title	Standard for the Installation of Lightning Protection Systems
Standard:	API RP 579
Title	Recommended Practice for Fitness-for-Service
Standard:	API RP 753
Title	Management of Hazards Associated with Location of Process Plant Portable Buildings
Standard:	API Std 2000
Title	Venting Atmospheric and Low-Pressure Storage Tanks: Non-refrigerated and Refrigerated
Standard:	API RP 2016
Title	Guidelines and Procedures for Entering and Cleaning Petroleum Storage Tanks
Standard:	API RP 2021
Title	Fighting Fires in and Around Flammable and Combustible Liquid Atmospheric Petroleum Storage Tanks
Standard:	API Pub 2510
Title	Fire protection consideration for the design and operation of LPG Storage Facilities
Standard:	BS 5908
Title	Code of practice for fire precautions in the chemical and allied industries

Standard:	ANSI B113.1
Title	Safety standard for pumps for fire protection services
Standard:	ICC IFC-2006
Title	International Fire Code

Chapter-2

8. Pressure Relieving Devices

(1)	**Standard:**	API RP 520 (Part I)
	Title	Sizing, Selection, and Installation of Pressure-Relieving Devices in Refineries: Part I - Sizing and Selection
	Description:	This recommended practice applies to the sizing and selection of pressure relief devices used in refineries and related industries for equipment that has a maximum allowable working pressure of 15 psig [103 kPag] or greater. The pressure relief devices covered in this recommended practice is intended to protect unfired pressure vessels and related equipment against overpressure from operating and fire contingencies.
(2)	**Standard:**	API RP 520 (Part II)
	Title	Sizing, Selection, and Installation of Pressure-Relieving Devices in Refineries-Part II, Installation
	Description:	This recommended practice covers methods of installation for pressure-relief devices for equipment that has a maximum allowable working pressure (MAWP) of 15 psig (1.03 bar g or 103 kPa) or greater. It covers gas, vapor, steam, two-phase and incompressible fluid service; it does not cover special applications that require unusual installation considerations.
(3)	**Standard:**	API 521
	Title	Guide for Pressure-Relieving and Depressuring Systems
	Description:	A guide for plant engineers in the design, installation, and operation of pressure-relieving and depressuring systems. Guidelines are provided for examining principal causes of overpressure; determining individual relieving rates; and selecting and designing disposal systems, including such component parts as vessels, flares, and vent stacks. Suggested solutions to the immediate design and economic and safety problems involved in pressure-relieving discharge systems are presented. A section regarding flare gas recovery is also included in this standard.

(4)	**Standard:**	API RP 554
	Title	Process Instrument and Control
	Description:	Covers performance requirements and considerations for the section, specification, installation and testing of process instrumentation and control systems. Control centers as used in the petroleum industry are also covered. This practice is not intended to be used as a purchase specification, but makes recommendations from minimum requirements and can be used to provide guidance for the development of detailed designs and specifications.

(5)	**Other relevant standards are:**	
Standard:		API Std 537
Title		Flare Details for General Refinery and Petrochemical Service

Chapter-3

9. Above Ground Atmospheric and Low Pressure Petroleum Storage Tanks

(1)	**Standard:**	API Std 620
	Title	Design and Construction of Large, Welded, Low-Pressure Storage Tanks
	Description:	The API Downstream Segment has prepared this standard to cover large, field-assembled storage tanks of the specific types described that contain petroleum intermediates (gases or vapors) and finished products, as well as other liquid products commonly handled and stored by the various branches of the industry. The rules presented in this standard do not cover all details of design and construction due to variety of tank sizes and shapes that may be constructed. Where complete rules for a specific design are not given, the intent is for the Manufacturer to provide design and construction details that are as safe as those which would otherwise be provided by this standard.

(2)	**Standard:**	API 650
	Title	Welded Steel Tanks for Oil Storage
	Description:	This standard is designed to provide the petroleum industry with tanks of adequate safety and reasonable economy for use in the storage of petroleum, petroleum products, and other liquid products commonly handled and stored by the various branches of the petroleum industry. It is intended to help purchasers and

manufacturers in ordering, fabricating, and erecting tanks. Standard 650 covers material, design, fabrication, erection, and testing requirements for vertical, cylindrical, aboveground, closed- and open-top, welded steel storage tanks in various and capacities for internal pressures approximating atmospheric pressure, but a higher internal pressure is permitted when additional requirements are met. This standard applies only to tanks whose entire bottom is uniformly supported; and to tanks in non-refrigerated service, that have a maximum operating temperature of 90 deg C (200 deg F).

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(3) **Standard:** API Std 2000

Title Venting Atmospheric and Low-Pressure Storage Tanks: Non-refrigerated and Refrigerated

Description: This standard covers the normal and emergency vapor venting requirements for aboveground liquid petroleum or petroleum products storage tanks, and aboveground and underground refrigerated storage tanks designed for operation at pressures from vacuum through 15 pounds per square inch gauge (1.034 bar gauge).

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(4) **Standard:** API RP 2003

Title Protection Against Ignitions Arising out of Static, Lightning, and Stray Currents

Description: This recommended practice presents the current state of knowledge and technology in the fields of static electricity, lightning, and stray currents applicable to the prevention of hydrocarbon ignition in the petroleum industry and is based on both scientific research and practical experience.

The principles discussed in this recommended practice are applicable to other operations where ignitable liquids and gases are handled. Their use should lead to improved safety practices and evaluations of existing installations and procedures. When the narrow limits of static electricity ignition are properly understood, fire investigators should be encouraged to search more diligently for the true ignition sources in instances where static ignition is unlikely or impossible.

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(5) **Standard:** API 2350

Title Overfill Protection for Petroleum Storage Tanks

Description: This recommended practice prevents petroleum storage tanks from being overfilled is an important safety and environmental concern. Tank overfills can be effectively reduced by developing

and implementing practical and safe operating procedures for storage facilities and by providing for careful selection and application of equipment, scheduled maintenance programs, and employee training. Covers overfill protection for all aboveground storage tanks in petroleum facilities, including refineries, terminals, bulk plants, and pipeline terminals that receive Class I (flammable) liquids from mainline pipelines or marine vessels.

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(6) **Standard:** API Std 2510

Title Design and Construction of Liquefied Petroleum Gas Installations (LPG)

Description: This standard covers the design, construction, and location of liquefied petroleum gas (LPG) installations at marine and pipeline terminals, natural gas processing plants, refineries, petrochemical plants, or tank farms. This standard covers storage vessels, loading and unloading systems, piping, or and related equipment.

The size and type of the installation; the related facilities on the site; the commercial, industrial, and residential population density in the surrounding area; the terrain and climate conditions; and the type of LPG handled are discussed. Generally speaking, the larger the installation and the greater the population density of the surrounding area, the more stringent are the design requirements.

Design and construction considerations peculiar to refrigerated storage, including auto refrigerated storage, are covered in this standard.

The provisions of this standard are intended for application to new installations. This standard can be used to review and evaluate existing storage facilities. However, the feasibility of applying this standard to facilities, equipment, structures, or installations that were already in place or that were in the process of construction or installation before the date of this publication, must be evaluated on a case-by-case basis considering individual circumstances and sites.

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(7) **Standard:** API 2550

Title: Method for Measurement and Calibration of Upright Cylindrical Tanks

Description: This standard describes the procedures for calibrating upright

cylindrical tanks larger than a barrel or drum. It is presented in two parts:

- Part I (Sections 1 to 41) outlines procedures for making necessary measurements to determine total and incremental tank volumes;
- Part II (Sections 42 to 58) presents the recommended procedure for computing volumes.

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(8) **Standard:** API Std 2555
Title: Method for Liquid Calibration of Tanks
Description: This standard describes the procedure for calibrating tanks, or portions of tanks, larger than a barrel or drum by introducing or withdrawing measured quantities of liquid.

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(9) **Standard:** API Std 2610
Title Design, Construction, Operation, Maintenance, and Inspection of Terminal & Tank Facilities
Description: API Standard 2610 covers the design, construction, operation, inspection, and maintenance of petroleum terminal and tank facilities associated with marketing, refining, pipeline, and other similar activities. This standard covers the issues of site selection and spacing, pollution prevention and waste management, safe operation, fire prevention and protection, tanks, dikes and beams, mechanical systems, product transfer, corrosion protection, structures, utilities and yard, and removals and decommissioning.

The purpose of this standard is to consolidate a wide base of current industry experience, knowledge, information, and management practices into a cohesive standard, and may be used as a resource and management guide by those responsible for terminal and tank facilities.

API has developed this document to foster greater awareness and assist the industry in addressing environmental, health, and safety concerns.

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(10) Other related standards are:

Standard: ANSI/API 510
Title Pressure Vessel Inspection Code: In-Service Inspection, Rating, Repair, and Alteration,

Standard: ANSI/API Std 521
Title Pressure-relieving and De-pressuring Systems,

Standard:	ANSI/API RP 575
Title	Guidelines and Methods for Inspection of Existing Atmospheric and Low-pressure Storage Tanks.
Standard:	API Std 620
Title	Design and Construction of Large, Welded, Low-Pressure Storage Tanks.
Standard:	API Std 650
Title	Welded Steel Tanks for Oil Storage
Standard:	ANSI/API RP 651
Title	Cathodic Protection of Aboveground Petroleum Storage Tanks,
Standard:	API Std 653
Title	Tank Inspection, Repair, Alteration, and Reconstruction
Standard:	API Std 2000
Title	Venting Atmospheric and Low-Pressure Storage Tanks: Non-refrigerated and Refrigerated

Chapter-4

10. Underground Storage Tanks

(1)	**Standard:**	API RP 1615
	Title	Installation of Underground Petroleum Storage Systems
	Description:	This standard is a guide to procedures and equipment that should be used for the proper installation of underground petroleum storage systems. For use by architects, engineers, tank owners, tank operators, and contractors. It applies to underground storage tank systems that store petroleum products at retail and commercial facilities.
(2)	**Standard:**	API RP 1632
	Title	Cathodic Protection of Underground Petroleum Storage Tanks and Piping Systems
	Description:	Covers two methods of providing cathodic protection for buried steel petroleum storage and dispensing systems. Provides information specific to buried steel structures such as motor fuel storage tanks and delivery piping waste oil tanks, heating-oil tanks, and automobile lifts installed at service stations.

	Related standard:	NACE RP0285-95 - Standard Recommended Practice - Corrosion Control of Underground Storage Tank Systems by Cathodic Protection.

(3)	**Standard:**	API Std 2000
	Title	Venting Atmospheric and Low-Pressure Storage Tanks: Non-refrigerated and Refrigerated
	Description:	This standard covers the normal and emergency vapor venting requirements for above ground liquid petroleum or petroleum products storage tanks, and above ground and underground refrigerated storage tanks designed for operation at pressures from vacuum through 15 pounds per square inch gauge (1.034 bar gauge).
	Related standard:	API Std 620 - Design and Construction of Large, Welded, Low-Pressure Storage Tanks,

(4)	**Standard:**	UL 58
	Title	Steel Underground Tanks for Flammable and Combustible Liquids
	Description:	This standard covers requirements for horizontal atmospheric-type steel tanks intended for the storage underground of flammable and combustible liquids. These requirements cover single wall tanks, secondary containment tanks, multiple compartment single wall and multiple compartment secondary containment tanks. Tanks covered by these requirements are cylindrical tanks that are fabricated, inspected, and tested for leakage before shipment from the factory as completely assembled vessels.

(5)	**Standard:**	UL 1316
	Title	Glass Fiber Reinforced Plastic Underground Storage Tanks for Petroleum Products, Alcohols, and Alcohol-Gasoline Mixtures
	Description:	This standard covers requirements for spherical or horizontal cylindrical, atmospheric-type tanks of glass-fiber-reinforced plastic (FRP) that are intended for the underground storage of petroleum-based flammable and combustible liquids, alcohols, and alcohol-blended fuels. These requirements cover tanks of either single- or double-wall construction. A double-wall tank is a tank within a tank, capable of being provided with means to detect a leak in either tank.

Tanks are completely assembled and tested for leakage before shipment.

These requirements do not cover optional accessories for these tanks, such as heating coils or hot wells; nor do they cover compartmented tanks.

Chapter-5

11. LPG Storage Facilities

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(1) **Standard:** API Std 2510

Title Design and Construction of Liquefied Petroleum Gas Installations (LPG)

Description: This standard covers the design, construction, and location of liquefied petroleum gas (LPG) installations at marine and pipeline terminals, natural gas processing plants, refineries, petrochemical plants, or tank farms. This standard covers storage vessels, loading and unloading systems, piping, or and related equipment.

The size and type of the installation; the related facilities on the site; the commercial, industrial, and residential population density in the surrounding area; the terrain and climate conditions; and the type of LPG handled are discussed. Generally speaking, the larger the installation and the greater the population density of the surrounding area, the more stringent are the design requirements.

Design and construction considerations peculiar to refrigerated storage, including auto refrigerated storage, are covered in this standard.

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(2) **Standard:** API Publ 2510A

Title Fire-Protection Considerations for the Design and Operation of Liquefied Petroleum Gas (LPG) Storage Facilities

Description: This publication supplements API Standard 2510 and addresses the design, operation, and maintenance of liquefied petroleum gas (LPG) storage facilities from the standpoint of prevention and control of releases, fire protection design, and fire control measures. The history of LPG storage facility safety experience, facility design philosophy, operating and maintenance procedures, and various fire protection and fire-fighting

approaches are presented. The storage facilities covered are LPG installations (storage vessels and associated loading/unloading/transfer systems) at marine and pipeline terminals, natural gas processing plants, refineries, petrochemical plants, and tank farms.

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(3) **Standard:** NFPA 58
Title Liquefied Petroleum Gas Code
Description: Important and expanded coverage in this standard reduces the risk of propane fires and explosions. LP-Gas Code is a source for LP-Gas safety requirements which *interalia* gives the criteria for the safe design, construction, installation and operation of all LP-Gas systems, as well as highway transportation of LP-Gas. This code includes section that addresses small LP-Gas system operators and aids compliance with DOT regulations. This standard covers the following:

- Location requirements for heaters;
- Table of small container appurtenances;
- Rule to require notification of trackside transfer from rail cars;
- New coverage of elevated pressure propane systems (20-50psi) used in cogeneration systems, micro turbines, metal cutting and similar industrial operations, and
- Clarified requirements for flexible connectors used as part of piping systems

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Chapter-6

12. Compressor and Drivers

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(1) **Standard:** API Spec 7B-11C
Title: Specification for Internal-Combustion Reciprocating Engines for Oil Field Service
Description: Covers methods for determining maximum brake horsepower and fuel consumption rates of internal-combustion bare engines and power units; provides for the manufacturer's maximum horsepower rating of such equipment for specific service applications; and gives methods for testing and rating of radiator-type cooling units

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(2) **Standard:** ANSI/API 11P
Title: Specification for Packaged Reciprocating Compressors for Oil

and Gas Production Services

Description: Covers requirements for packaged high speed separable or belt driven oil-field type engine driven compressors in natural gas service. It contains data sheets used to set out service conditions, material requirements, and fabricator's design sheets.

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(3) **Standard:** API Std 617

Title: Axial and Centrifugal Compressors and Expander-compressors for Petroleum, Chemical and Gas Industry Services

Description: This standard now covers the minimum requirements for axial compressors, integrally geared process centrifugal compressors and expander-compressors, as well as single shaft centrifugal compressors for use in the petroleum, chemical, and gas industries services that handle air or gas. This standard does not apply to fans (covered by API 673) or blowers that develop less than 34 kPa (5 psi) pressure rise above atmospheric pressure. This standard also does not apply to packaged, integrally-geared centrifugal plant and instrument air compressors, which are covered by API Std 672. Hot gas expanders over 300 C (570 F) are also not covered in this standard.

Related Standards: API 617 Data Sheets - Data Sheets for API Standard 617, Axial and Centrifugal Compressors and Expander-compressors for Petroleum, Chemical and Gas Industry Services

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(4) **Standard:** API Std 618

Title: Reciprocating Compressors for Petroleum, Chemical, and Gas Industry Services

Description: This standard covers the minimum requirements for reciprocating compressors and their drivers for use in petroleum, chemical, and gas industry services for handling process air or gas with either lubricated or non-lubricated cylinders.

Compressors covered by this standard are moderate to low speed machines. Also included are related lubricating systems, controls, instrumentation, intercoolers, aftercoolers, pulsation suppression devices, and other auxiliary equipment. Compressors not covered by this standard are (a) integral gas-engine-driven compressors, (b) compressors with single-acting trunk-type (automotive-type) pistons that also serve as crossheads, and (c) either plant or instrument-air compressors that discharge at a gauge pressure of 9 bar (125 psig) or below.

		Requirements for packaged high-speed reciprocating compressors for oil and gas production services are covered in ISO 13631.
	Related Standards:	API 618 Datasheets - Mechanical Equipment Data Sheets
(5)	**Standard:**	API Std 619
	Title:	Rotary-Type Positive-Displacement Compressors for Petroleum, Petrochemical, and Natural Gas Industries
	Description:	This standard covers the minimum requirements for dry and oil-flooded helical lobe rotary compressors used for vacuum or pressure or both in petroleum, petrochemical, and natural gas industries. It is intended for compressors that are in special-purpose applications. It does not cover general purpose air compressors, liquid ring compressors, and vane-type compressors.
	Related Standards:	API 619 Data Sheet - API Standard 619 Data Sheets
(6)	**Standard:**	API Std 672
	Title:	Packaged, Integrally Geared Centrifugal Air Compressors for Petroleum, Chemical, and Gas Industry Services
	Description:	This standard covers the minimum requirements for constant-speed, packaged, general purpose integrally geared centrifugal air compressors, including their accessories.
	Related Standards:	API 672 Data Sheets - Datasheets for API 672: Packaged, Integrally Geared Centrifugal Air Compressors for Petroleum, Chemical, and Gas Industry Services
(7)	**Standard:**	ISO 10437
	Title:	Petroleum, petrochemical and natural gas industries - Steam turbines - Special-purpose applications
	Description:	ISO 10437 specifies requirements and gives recommendations for the design, materials, fabrication, inspection, testing and preparation for shipment of special-purpose steam turbines. It also covers the related lube-oil systems, instrumentation, control systems and auxiliary equipment.
(8)	**Standard:**	ISO 10439
	Title:	Petroleum, chemical and gas service industries - Centrifugal compressors
	Description:	ISO 10439 specifies requirements and gives recommendations for the design, materials, fabrication, inspection, testing and preparation for shipment of centrifugal compressors for use in the petroleum, chemical and gas service industries. It is not

applicable to machines that develop less than 35 kPa above atmospheric pressure, nor is it applicable to packaged, integrally geared centrifugal air compressors, which are covered in ISO 10442.

(9)	**Standard:**	ISO 13707
	Title:	Petroleum and natural gas industries -- Reciprocating compressors
	Description:	This International Standard covers the minimum requirements for reciprocating compressors and their drivers used in the petroleum and natural gas industries with either lubricated or non lubricated cylinders. This International Standard may be used for other services or in other industries by agreement. Compressors covered by this International Standard are moderate to low-speed and in critical services. Also included are related lubricating systems, controls, instrumentation, intercoolers, aftercoolers, pulsation suppression devices and other auxiliary equipment.

(10)	**Other related standards:**	
Standard:		API Spec. 11K
Title:		Air exchanger coolers for packaged compressors units
Standard:		API Spec. 11P
Title:		Packaged high-speed separable engine driven reciprocating gas compressors units

Chapter-7

13. Pumps

(1)	**Standard:**	API STD 610
	Title:	Centrifugal Pumps for Petroleum, Petrochemical and Natural Gas Industries
	Description:	API Standard 610 specifies requirements for centrifugal pumps, including pumps running in reverse as hydraulic power recovery turbines, for use in petroleum, petrochemical, and gas industry process services. It does not cover seal less pumps. Std. 610 is applicable to overhung pumps, between-bearings pumps, and vertically-suspended pumps.

(2)	**Standard:**	API Std 674
	Title:	Positive Displacement Pumps - Reciprocating
	Description:	Covers the minimum requirements for reciprocating positive

		displacement pumps for use in petroleum, chemical, and gas industry services. Both direct-acting and power-frame types are included
	Related Standards:	API 674 Datasheet - Positive Displacement Pumps - Reciprocating.

(3)	**Standard:**	API Std 675
	Title:	Positive Displacement Pumps - Controlled Volume
	Description:	Covers the minimum requirements for controlled volume positive displacement pumps for use in service in the petroleum, chemical, and gas industries. Both packed-plunger and diaphragm types are included. Diaphragm pumps that use direct mechanical actuation are excluded.

(4)	**Standard:**	ISO 13709
	Title:	Centrifugal pumps for petroleum, petrochemical and natural gas industries
	Description:	ISO 13709 specifies requirements for centrifugal pumps, for use in petroleum, petrochemical and gas industry process services. ISO 13709 is applicable to overhung pumps, between-bearings pumps and vertically-suspended pumps.

Chapter-8

14. Heaters

(1)	**Standard:**	API Spec 12K
	Title:	Indirect-Type Oil Field Heaters
	Description:	Covers minimum requirements for the design, fabrication, and plant testing of indirect heaters that are used in the production of oil and gas, and are located at some point on the producing flow line between the wellhead and pipeline.

(2)	**Standard:**	API RP 556
	Title:	Instrumentation and Control Systems for Fired Heaters and Steam Generators
	Description:	API RP 556 was written to aid in the installation of the more generally used measuring, control, and analytical instruments; transmission systems; and related accessories to achieve safe, continuous, accurate and efficient operation with minimum maintenance. Although the information has been prepared primarily for petroleum refineries, much of it is applicable without change in chemical plants, gasoline plants, and similar installations.

(3)	**Standard:**	API 560
	Title:	Fired Heaters for General Refinery Services
	Description:	Applies to fired heaters for general refinery services. It covers the minimum requirements for their design, materials, fabrication, inspection, testing, preparation for shipment, and erection.
	Related Standards:	ANSI/API 560 Data Sheets - Data Sheets for Fired Heaters for General Refinery Services
(4)	**Standard:**	ANSI/API Std 530
	Title:	Calculation of Heater-tube Thickness in Petroleum Refineries
	Description:	This International Standard specifies the requirements and gives recommendations for the procedures and design criteria used for calculating the required wall thickness of new tubes and associated component fittings for petroleum-refinery heaters. These procedures are appropriate for designing tubes for service in both corrosive and non-corrosive applications. These procedures have been developed specifically for the design of refinery and related process-fired heater tubes (direct-fired, heat-absorbing tubes within enclosures). These procedures are not intended to be used for the design of external piping.
(5)	**Standard:**	BS 4076
	Title:	Specification for steel chimneys
	Description:	Structural design and construction for chimneys (with or without linings) and their supports. Applications of linings or cladding. Insulation, maintenance, protective treatments, inspection. Effects of wind.
(6)	**Standard:**	ASTM C27
	Title:	Standard Classification of Fireclay and High-Alumina Refractory Brick
	Description:	This classification covers machine-made fireclay and high-alumina refractory brick, and its purpose is to set forth the various classes and types of these materials in accordance with their normal and characteristic properties, which are important in their use.

Chapter-9

15. Heat Exchangers

(1)	**Standard:**	API Std 660
	Title:	Shell-and-tube Heat Exchangers
	Description:	This Standard specifies requirements and gives recommendations for the mechanical design, material selection, fabrication, inspection, testing and preparation for shipment of shell-and-tube heat exchangers for the petroleum, petrochemical and natural gas industries. It is applicable to the following types of shell-and-tube heat exchangers: heaters, condensers, coolers and reboilers. It is not applicable to vacuum-operated steam surface condensers and feed-water heaters.
(2)	**Standard:**	API Std 661
	Title:	Air-Cooled Heat Exchangers for General Refinery Services
	Description:	API Std 661 gives requirements and recommendations for the design, materials, fabrication, inspection, testing and preparation for shipment of air-cooled heat exchangers for use in the petroleum and natural gas industries.
(3)	**Standard:**	ISO 13706
	Title:	Petroleum, petrochemical and natural gas industries - Air-cooled heat exchangers
	Description:	ISO 13706 gives requirements and recommendations for the design, materials, fabrication, inspection, testing and preparation for shipment of air-cooled heat exchangers for use in the petroleum and natural gas industries.
(4)	**Other relevant standards:**	
Standard:		ISO 15547
Title:		Petroleum and natural gas industries -- Plate heat exchangers
Standard:		TEMA C
Title:		Specifications and Design practices for heat exchangers in general process services
Standard:		TEMA R
Title:		Specifications and Design practices fro heat exchangers in severe services

Chapter-10

16. Vessels

(1)	**Standard:**	ASME Section I
	Title:	ASME Boiler and Pressure Vessel Code, Section I: Rules for Construction of Power Boilers
	Description:	This section provides requirements for all methods of construction of power, electric, and miniature boilers; high temperature water boilers used in stationary service; and power boilers used in locomotive, portable, and traction service. Rules pertaining to use of the V, A, M, PP, S and E Code symbol stamps are also included. The rules are applicable to boilers in which steam or other vapor is generated at a pressures exceeding 15 psig, and high temperature water boilers intended for operation at pressures exceeding 160 psig and or temperatures exceeding 250 degree F. Super heaters, economizers, and other pressure parts connected directly to the boiler without intervening valves are considered as part of the scope of Section 1.
(2)	**Standard:**	ASME Section IIA
	Title:	ASME Boiler and Pressure Vessel Code, Section II: Materials - Part A: Ferrous Material Specifications
	Description:	This part is a service book to the other Code Sections, providing material specifications for ferrous materials adequate for safety in the field of pressure equipment. These specifications contain requirements and mechanical properties, test specimens, and methods of testing. They are designated by SA numbers and are derived from ASTM "A" specifications.
(3)	**Standard:**	ASME Section IIB
	Title:	ASME Boiler and Pressure Vessel Code, Section II: Materials - Part B: Nonferrous Material Specifications
	Description:	This part is a service book to the other Code Sections providing material specifications for nonferrous materials adequate for safety in the field of pressure equipment. These specifications contain requirements for heat treatment, manufacture, chemical composition, heat and product analyses, mechanical test requirements and mechanical properties, test specimens, and methods of testing. They are designated by SB numbers and are derived from ASTM "B" specifications.
(4)	**Standard:**	ASME Section IIC

Title: ASME Boiler and Pressure Vessel Code, Section II: Materials - Part C: Specifications for Welding Rods, Electrodes and Filler Metals.

Description: This is a service book to the other Code Sections providing material specifications for the manufacture, acceptability, chemical composition, mechanical usability, surfacing, testing requirements and procedures, operating characteristics, and intended uses for welding rods, electrodes and filler metals. These specifications are designated by SFA numbers and are derived from AWS specifications.

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(5) **Standard:** ASME Section IID Metric

Title: ASME Boiler and Pressure Vessel Code, Section II: Materials - Part D: Properties (Metric)

Description: This is a service book to Code Sections providing tables of design stress values, tensile and yield strength values, and tables and charts of material properties. Part D facilitates ready identification of specific materials to specific Sections of the Boiler and Pressure Vessel Code. Part D contains appendices which contain criteria for establishing allowable stress, the bases for establishing external pressure charts, and information required for approval of new materials.

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(6) **Standard:** ASME Section V

Title: ASME Boiler and Pressure Vessel Code, Section V: Nondestructive Examination

Description: This Section contains requirements and methods for nondestructive examination which are referenced and required by other code Sections. It also includes manufacturer's examination responsibilities, duties of authorized inspectors and requirements for qualification of personnel, inspection and examination. Examination methods are intended to detect surface and internal discontinuities in materials, welds, and fabricated parts and components. A glossary of related terms is included.

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(7) **Standard:** ASME Section VIII

Title: ASME Boiler & Pressure Vessel Code

Description: ASME Section VIII comprise of 3 - Set which are as follows:

Div I ASME Section VIII-DIV 1

Title: Boiler and Pressure Vessel Code, Section VIII, Division 1: Rules for Construction of Pressure Vessels

Description: This Division of Section VIII provides requirements applicable to

the design, fabrication, inspection, testing, and certification of pressure vessels operating at either internal or external pressures exceeding 15 psig. Such pressure vessels may be fired or unfired. Specific requirements apply to several classes of material used in pressure vessel construction, and also to fabrication methods such as welding, forging and brazing. It contains mandatory and non-mandatory appendices detailing supplementary design criteria, nondestructive examination and inspection acceptance standards. Rules pertaining to the use of the U, UM and UV Code symbol stamps are also included.

Div II ASME Section VIII-DIV 2

Title: ASME Boiler and Pressure Vessel Code, Section VIII, Division 2: Alternative Rules

Description: These rules provide an alternative to the minimum requirements for pressure vessels under Division 1 rules. In comparison the Division 1, Division 2 requirements on materials, design, and nondestructive examination are more rigorous; however, higher design stress intensify values are permitted. Division 2 rules cover only vessels to be installed in a fixed location for a specific service where operation and maintenance control is retained during the useful life of the vessel by the user who prepares or causes to be prepared the design specifications. These rules may also apply to human occupancy pressure vessels typically in the diving industry.

Div III ASME Section VIII-DIV 3

Title: ASME Boiler and Pressure Vessel Code, Section VIII, Division 3: Alternative Rules for Construction of High Pressure Vessels

Description: This Division of Section VIII provides requirements applicable to the design, fabrication, inspection, testing, and certification of pressure vessels operating at either internal or external pressures generally above 10,000 psi. Such vessels may be fired or unfired. This pressure may be obtained from an external source, a process reaction, by the application of heat from a direct or indirect source, or any combination thereof. The operation and maintenance control is retained during the useful life of the vessel by the user who prepares or causes to be prepared the design specifications. Division 3 does not establish maximum pressure limits for either Section VIII, Divisions 1 or 2, nor minimum pressure limits for this Division. Rules pertaining to the use of the UV3 Code symbol stamps are also included.

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(8) **Standard:** ASME Section IX

Title: ASME Boiler and Pressure Vessel Code - Section IX: Welding and Brazing Qualifications

Description: Section IX of the ASME Boiler and Pressure Vessel Code relates to the qualification of welders, welding operators, brazers, and brazing operators and the procedures employed in welding of brazing in accordance with the ASME Boiler and Pressure Vessel Code and the ASME B31 Code for Pressure Piping. Section IX establishes the basic criteria for welding and brazing which are observed in the preparation of welding and brazing requirements that affect procedure and performance. The purpose of the Welding Procedure Specification (WPS) and Procedure Qualification Record (PQR) is to determine that the weldment proposed for construction is capable of having the required properties for its intended application.

Related Standards: Companion Guide to the ASME Boiler & Pressure Vessel Code, Volumes 1, 2 and 3

Chapter-11

17. Pipeline and Piping

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(1) **Standard:** ASME B31.1

Title: Power Piping

Description: This code prescribes minimum requirements for the design, materials, fabrication, erection, test, and inspection of power and auxiliary service piping systems for electric generation stations, industrial institutional plants, central and district heating plants. The code covers boiler external piping for power boilers and high temperature, high pressure water boilers in which steam or vapor is generated at a pressure of more than 15 PSIG; and high temperature water is generated at pressures exceeding 160 PSIG and/or temperatures exceeding 250°F.

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(2) **Standard:** ASME B31.3

Title: Process Piping

Description: Rules for piping typically found in petroleum refineries; chemical, pharmaceutical, textile, paper, semiconductor, and cryogenic plants; and related processing plants and terminals. This code prescribes requirements for materials and components, design, fabrication, assembly, erection, examination, inspection, and testing of piping. This Code applies to piping for all fluids including: (1) raw, intermediate, and finished chemicals; (2) petroleum products; (3) gas, steam, air and water; (4) fluidized

solids; (5) refrigerants; and (6) cryogenic fluids. Also included is piping which interconnects pieces or stages within a packaged equipment assembly.

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(3) **Standard:** ASME B31.4

Title: Pipeline Transportation Systems for Liquid Hydrocarbons and Other Liquids

Description: This Code prescribes requirements for the design, materials, construction, assembly, inspection, and testing of piping transporting liquids such as crude oil, condensate, natural gasoline, natural gas liquids, liquefied petroleum gas, carbon dioxide, liquid alcohol, liquid anhydrous ammonia and liquid petroleum products between producers' lease facilities, tank farms, natural gas processing plants, refineries, stations, ammonia plants, terminals (marine, rail and truck) and other delivery and receiving points. Piping consists of pipe, flanges, bolting, gaskets, valves, relief devices, fittings and the pressure containing parts of other piping components. It also includes hangers and supports, and other equipment items necessary to prevent overstressing the pressure containing parts. Requirements for offshore pipelines are also found in this document. In addition to above scope of this standards also includes:

(a) Primary and associated auxiliary liquid petroleum and liquid anhydrous ammonia piping at pipeline terminals (marine, rail and truck), tank farms, pump stations, pressure reducing stations and metering stations, including scraper traps, strainers, and prover loop;

(b) Storage and working tanks including pipe-type storage fabricated from pipe and fittings, and piping interconnecting these facilities;

(c) Liquid petroleum and liquid anhydrous ammonia piping located on property which has been set aside for such piping within petroleum refinery, natural gasoline, gas processing, ammonia, and bulk plants; and

(d) Those aspects of operation and maintenance of liquid pipeline systems relating to the safety and protection of the general public, operating company personnel, environment, property and the piping systems.

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(4) **Standard:** ANSI/ASME B31.8

Title: Gas Transmission and Distribution Piping Systems

Description: This Code covers the design, fabrication, installation, inspection, and testing of pipeline facilities used for the transportation of gas.

This Code also covers safety aspects of the operation and maintenance of those facilities.

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(5) **Standard:** ANSI/ASME B36.10M

Title: Welded and Seamless Wrought Steel Pipe

Description: This Standard covers the standardization of dimensions of welded and seamless wrought steel pipe for high or low temperatures and pressures. The word pipe is used, as distinguished from tube, to apply to tubular products of dimensions commonly used for pipeline and piping systems. Pipe NPS 12 (DN 300) and smaller have outside diameters numerically larger than their corresponding sizes. In contrast, the outside diameters of tubes are numerically identical to the size number for all sizes.

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(6) **Standard:** ANSI/ASME B36.19M

Title: Stainless Steel Pipe

Description: This Standard covers the standardization of dimensions of welded and seamless wrought stainless steel pipe for high or low temperatures and pressures. The word pipe is used, as distinguished from tube, to apply to tubular products of dimensions commonly used for pipeline and piping systems. Pipes NPS 12 (DN 300) and smaller have outside diameters numerically larger than their corresponding sizes. In contrast, the outside diameters of tubes are numerically identical to the size number for all sizes. The wall thicknesses for NPS 14 through 22, inclusive (DN 350-550, inclusive), of Schedule 10S; NPS 12 (DN 300) of Schedule 40S; and NPS 10 and 12 (DN 250 and 300) of Schedule 80S are not the same as those of ASME B36.10M.

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(7) **Standard:** ANSI/AWS A5.1/A5.1M

Title: Specification for Carbon Steel Electrodes for Shielded Metal Arc Welding

Description: This specification establishes the requirements for classification of carbon steel electrodes for shielded metal arc welding. The requirements include mechanical properties of weld metal, weld metal soundness, and usability of electrode. Requirements coverings, standard sizes and lengths, marking, manufacturing, and packaging are also included.

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(8) **Standard:** ANSI/AWS A5.5/A5.5M

Title: Specification for Low-Alloy Steel Electrodes for Shielded Metal Arc Welding

Description: This specification prescribes the requirements for classification of low-alloy steel covered electrodes used for shielded metal arc welding. The requirements include chemical composition and mechanical properties of weld metal, weld metal soundness, usability tests of electrodes, and moisture tests of the low-hydrogen electrode covering. Requirements for standard sizes and lengths, marking, manufacturing, and packaging are also included.

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(9) **Standard:** ANSI/AWS A5.9/A5.9M

Title: Specification for Bare Stainless Steel Welding Electrodes and Rods

Description: The classification and other requirements for more than forty-five bare stainless steel electrodes (solid and composite), rods, and strips are specified, including a number of duplex alloys previously unclassified.

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(10) **Standard:** ANSI/AWS A5.17/A5.17M

Title: Specification for Carbon Steel Electrodes and Fluxes for Submerged Arc Welding

Description: This specification provides requirements for the classification of solid and composite carbon steel electrodes and fluxes for submerged arc welding. Electrode classification is based on chemical composition of the electrode for solid electrodes, and chemical composition of the weld metal for composite electrodes. Flux classification is based on the mechanical properties of weld metal produced with the flux and an electrode classified herein.

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(11) **Standard:** ANSI/AWS A5.18/A5.18M

Title: Specification for Carbon Steel Electrodes and Rods for Gas Shielded Arc Welding

Description: This specification prescribes the requirements for classification of solid carbon steel electrodes and rods, composite stranded carbon steel electrodes, and composite metal cored carbon steel electrodes for gas shielded arc welding.

Classification is based on chemical composition of the electrode for solid electrodes and rods, chemical composition of weld metal for composite stranded and composite metal cored electrodes and the as-welded mechanical properties of the weld metal for each. Additional requirements are included for manufacture, sizes, lengths, and packaging.

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(12) **Standard:** API Spec 5L

Title: Specification for Line Pipe

Description: This specification provides standards for pipe suitable for use in conveying gas, water, and oil in the oil and natural gas industries. Spec 5L covers seamless and welded steel line pipe. It includes plain-end, threaded-end, and belled-end pipe, as well as through-the-flowline (TFL) pipe and pipe with ends prepared for use with special couplings.

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(13) **Standard:** API RP 5L1

Title: Railroad Transportation of Line Pipe

Description: The recommendations provided herein apply to the transportation on railcars of API Specification 5L steel line pipe in sizes 23/8 and larger in lengths longer than single random. These recommendations cover coated or uncoated pipe, but they do not encompass loading practices designed to protect pipe coating from damage.

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(14) **Standard:** API RP 14E

Title: Recommended Practice for Design and Installation of Offshore Products Platform Piping Systems

Description: Recommends minimum requirements and guidelines for the design and installation of new piping systems on offshore production platforms. Includes general recommendations on design and application of pipe, valves, and fittings for typical processes; general information on installation, quality control, and items related to piping systems such as insulation; and specific recommendations for the design of particular piping systems.

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(15) **Standard:** API 570

Title: Piping Inspection Code: Inspection, Repair, Alteration, and Re-rating of In-Service Piping Systems

Description: Covers inspection, repair, alteration, and re-rating procedures for in-service metallic piping systems. Establishes requirements and guidelines that allow owner/users of piping systems to maintain the safety and mechanical integrity of systems after they have been placed into service. Intended for use by organizations that maintain or have access to an authorized inspection agency, repair organization, and technically qualified personnel.

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(16) **Standard:** API Std 600

Title: Steel Gate Valves - Flanged and Butt-welding Ends, Bolted Bonnets

Description: This International standard specifies the requirements for a

heavy-duty series of bolted bonnet steel gate valves for petroleum refinery and related applications where corrosion, erosion and other service conditions would indicate a need for full port openings, heavy wall sections and large stem diameters.

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(17) **Standard:** API Std 1104
Title: Welding of Pipelines and Related Facilities
Description: This standard covers the gas and arc welding of butt, fillet, and socket welds in carbon and low-alloy steel piping used in the compression, pumping, and trans-mission of crude petroleum, petroleum pro-ducts, fuel gases, carbon dioxide, nitrogen and, where applicable, covers welding on distribution systems. It applies to both new construction and in-service welding.

This standard also covers the procedures for radiographic, magnetic particle, liquid penetrant, and ultrasonic testing, as well as the acceptance standards to be applied to production welds tested to destruction or inspected by radiographic, magnetic part, liquid penetrant, ultrasonic, and visual testing methods.

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(18) **Standard:** API RP 1107
Title: Pipeline Maintenance Welding Practices
Description: This recommended practice covers recommended maintenance welding practices that may be used when repairing or installing appurtenances on pipeline systems that are or have been in service in the transmission of petroleum products.

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(19) **Standard:** API RP 1110
Title: Pressure Testing of Steel Pipelines for the Transportation of Gas, Petroleum Gas, Hazardous Liquids, Highly Volatile Liquids or Carbon Dioxide
Description: This Recommended Practice (RP) provides guidelines for pressure testing steel pipelines for the transportation of gas, petroleum gas, hazardous liquids, highly volatile liquids or carbon dioxide. This RP provides guidance so that:

- Pipeline Operators can select a pressure test suitable for the conditions under which the test will be conducted. This includes, but is not limited to, pipeline material characteristics, pipeline operating conditions, and various types of anomalies or other risk factors that may be present.
- Pressure tests are planned in order to meet the overall objectives of the pressure test.
- Site-specific procedures are developed and followed

during all phases of the pressure testing process.

- Pressure tests consider both personnel safety and environmental impacts.
- Pressure tests are implemented by qualified personnel.
- Pressure tests are conducted in order to meet stated acceptance criteria and pressure test objectives.
- Pressure test records are developed, completed and retained for the useful life of the facility.

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(20) **Standard:** ASTM G8

Title: Standard Test Methods for Cathodic Disbonding of Pipeline Coatings

Description: These test methods cover accelerated procedures for simultaneously determining comparative characteristics of insulating coating systems applied to steel pipe exterior for the purpose of preventing or mitigating corrosion that may occur in underground service where the pipe will be in contact with inland soils and may or may not receive cathodic protection. They are intended for use with samples of coated pipe taken from commercial production and are applicable to such samples when the coating is characterized by function as an electrical barrier.

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(21) **Standard:** ASTM A53

Title: Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless

Description: This specification covers seamless and welded black and hot-dipped galvanized steel pipe in NPS 1/8 to NPS 26 [DN 6 to DN 650], inclusive, with nominal wall thickness as given in it. It shall be permissible to furnish pipe having other dimensions provided such pipe complies with all other requirements of this specification.

This specification covers the following types and grades:

- Type F–Furnace-butt welded, continuous welded Grade A;
- Type E–Electric-resistance welded, Grades A and B; and
- Type S–Seamless, Grades A and B.

ii) Pipe ordered under this specification is intended for mechanical and pressure applications and is also acceptable for ordinary uses in steam, water, gas, and air lines. It is suitable for welding, and suitable for forming operations involving coiling, bending, and flanging, subject to the following qualifications:

- Type F is not intended for flanging;

- When Types S and E are required for close coiling or cold bending, Grade A is the preferred grade. This provision is not intended to prohibit the cold bending of Grade B pipe;
- Type E is furnished either non-expanded or cold expanded at the option of the manufacturer.

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(22) **Standard:** ASTM A105

Title: Standard Specification for Carbon Steel Forgings for Piping Applications

Description: This specification covers forged carbon steel piping components for ambient- and higher-temperature service in pressure systems. Included are flanges, fittings, valves, and similar parts ordered either to dimensions specified by the purchaser or to dimensional standards such as the MSS, ASME, and API specifications referenced in Section. Forgings made to this specification are limited to a maximum weight of 10000 lb [4540 kg]. Larger forgings may be ordered to Specification A 266/A 266M. Although this specification covers some piping components machined from rolled bar and seamless tubular products, it does not cover raw material produced in these product forms. Supplementary requirements are provided in it for use when additional testing or inspection is desired.

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(23) **Standard:** ASTM A106

Title: Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service

Description: This specification covers seamless carbon steel pipe for high-temperature service in NPS 1/8 to NPS 48 inclusive, with nominal (average) wall thickness as given in ANSI B 36.10. It shall be permissible to furnish pipe having other dimensions provided such pipe complies with all other requirements of this specification. Pipe ordered under this specification shall be suitable for bending, flanging, and similar forming operations, and for welding. When the steel is to be welded, it is presupposed that a welding procedure suitable to the grade of steel and intended use or service will be utilized.

Supplementary requirements (S1 to S7) of an optional nature are provided for seamless pipe intended for use in applications where a superior grade of pipe is required.

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(24) **Standard:** ISO 15649

Title: Petroleum and natural gas industries -- Piping

Description: This International Standard specifies the requirements for design and construction of piping for the petroleum and natural gas industries, including associated inspection and testing. It is applicable to all piping within facilities engaged in the processing or handling of chemical, petroleum, natural gas or related products e.g petroleum refinery, loading terminal, natural gas processing plant (including liquefied natural gas facilities), offshore oil and gas production platforms, chemical plant, bulk plant, compounding plant, tank farm.

This International Standard is also applicable to packaged equipment piping which interconnects individual pieces or stages of equipment within a packaged equipment assembly for use within facilities engaged in the processing or handling of chemical, petroleum, natural gas or related products.

(25) Other related standards:

Standard: API Spec 5L5
Title: Marine Transportation of Line Pipe

Standard: API RP 582
Title: Recommended Practice and Supplementary Welding Guidelines for the Chemical, Oil, and Gas Industries

Standard: ANSI/AWS A5.4/A5.4M
Title: Specification for Stainless Steel Electrodes for Shielded Metal Arc Welding

Standard: PIP PNSC0001
Title: ASME B31.3 Metallic Piping Fabrication and Examination Specification

Standard: AWS API-M
Title: Study Guide for API Standard 1104 Welding of Pipelines and Related Facilities

Standard: AWS A5.23/A5.23M
Title: Specification for Low-Alloy Steel Electrodes and Fluxes for Submerged Arc Welding

Standard: ISO 3183
Title: Petroleum and natural gas industries - Steel pipe for pipeline transportation systems

Standard:	ISO/CD 13623
Title:	Petroleum and Natural Gas Industries - Pipeline Transportation Systems
Standard:	ISO 13847
Title:	Petroleum and natural gas industries -- Pipeline transportation systems -- Welding of pipelines
Standard:	ISO 14692
Title:	Petroleum and natural gas industries - Glass-reinforced plastics (GRP) piping

Chapter-12

18. Mechanical

ASME – American Society of Mechanical Engineers

(1)	**Standard:**	ASME B1.1
	Title:	Unified Inch Screw Threads, UN and UNR Thread Form
	Description:	This Standard specifies the thread form, series, class, allowance, tolerance, and designation for unified screw threads. (In order to emphasize that unified screw threads are based on inch modules, they may be denoted unified inch screw threads.) Several variations in thread form have been developed for unified threads; however, this Standard covers only UN and UNR thread forms.
(2)	**Standard:**	ASME B16.20
	Title:	Metallic Gaskets for Pipe Flanges: Ring-Joint, Spiral-Wound, and Jacketed
	Description:	This Standard covers materials, dimensions, tolerances, and markings for metal ring-joint gaskets, spiral-wound gaskets, and metal-jacketed gaskets. These gaskets are dimensionally suitable for use with flanges described in reference flange standards ASME B16.5, ASME B16.47, API Specification 6A, and ISO 10423. This Standard covers spiral-wound metal gaskets and metal-jacketed gaskets for use with raised-face and flat-face flanges.
(3)	**Standard:**	ASME B16.21
	Title:	Nonmetallic Flat Gaskets for Pipe Flanges
	Description:	This Standard covers types, sizes, materials, dimensions, tolerances, and markings for nonmetallic flat gaskets. These gaskets are dimensionally suitable for use with flanges

described in the referenced flange standards.

(4)	**Standard:**	ASME B16.47
	Title:	Large Diameter Steel Flanges: NPS 26 Through NPS 60
	Description:	This Standard covers pressure-temperature ratings, materials, dimensions, tolerances, marking, and testing for pipe flanges in sizes NPS 26 through NPS 60 and in ratings Classes 75, 150, 0300, 400, 600, and 900. Flanges may be cast, forged, or plate (for blind flanges only) materials, as listed in it. Requirements and recommendations regarding bolting and gaskets are also included.
(5)	**Standard:**	ASME B18.2.2
	Title:	Square and Hex Nuts (Inch Series)
	Description:	This Standard is intended to cover the complete general and dimensional data for the various types of inch series square and hex nuts recognized as "American National Standard." Also included are appendices covering gaging of slots in slotted nuts, wrench openings for nuts, and formulas on which dimensional data are based. It should be understood, however, that where questions arise concerning acceptance of product, the dimensions in the Tables shall govern over recalculation by formula. The inclusion of dimensional data in this Standard is not intended to imply that all of the products described herein are stock production sizes. Consumers are requested to consult with manufacturers concerning lists of stock production sizes.
(6)	**Standard:**	ASME B46.1
	Title:	Surface Texture, Surface Roughness, Waviness and Lay
	Description:	This Standard is concerned with the geometric irregularities of surfaces. It defines surface texture and its constituents: roughness, waviness, and lay. It also defines parameters for specifying surface texture. The terms and ratings in this Standard relate to surfaces produced by such means as abrading, casting, coating, cutting, etching, plastic deformation, sintering, wear, erosion, etc.

API – American Petroleum Institute

(7)	**Standard:**	API Spec 6D
	Title:	Specification for Pipeline Valves
	Description:	This International Standard specifies requirements and gives recommendations for the design, manufacturing, testing and documentation of ball, check, gate and plug valves for application in pipeline systems.

Valves for pressure ratings exceeding PN 420 (Class 2500) are not covered by this International Standard.

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(8) **Standard:** API Std 594
Title: Check Valves: Wafer, Wafer-Lug, and Double Flanged Type
Description: API Standard 594 covers design, material, face-to-face dimensions, pressure-temperature ratings, and examination, inspection, and test requirements for two types of check valves.

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(9) **Standard:** API Std 598
Title: Valve Inspection and Testing
Description: This standard covers inspection, examination, supplementary examinations, and pressure test requirements for resilient-seated, nonmetallic-seated (for example, ceramic), and metal-to-metal-seated valves of the gate, globe, plug, ball, check, and butterfly types.

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(10) **Standard:** API 601
Title: Metallic Gaskets for Piping
Description: This standard is a purchase specification for metallic, flat, ring-shaped gaskets for use in circular, raised-face, flanged pipe joints as described in ANSI B16.5, API 605, and MSS SP-44. Two types of gaskets are covered: double-jacketed corrugated gaskets and spiral-wound gaskets. Nominal sizes correspond to the nominal pipe sizes (NPS) in ASME B36.10M and to the pipe outside diameter (OD), when NPS is beyond the scope of ASME B36.10M. Certain sizes of these gaskets cannot be used with all flange types or flange bores.

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(11) **Standard:** API 602
Title: Compact Steel Gate Valves - Flanged, Threaded, Welding, and Extended-Body Ends
Description: Covers threaded-end, socket-welding-end, butt-welding-end, and flanged-end compact carbon steel gate valves in sizes NPS4 and smaller.

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(12) **Standard:** API Std 614
Title: Lubrication, Shaft-sealing and Oil-control Systems and Auxiliaries
Description: API 614 covers the minimum requirements for General Purpose and Special Purpose Oil Systems. The standard also includes requirements for Self-acting Gas Seal Support Systems. The standard includes the systems' components, along with the required controls and instrumentation. Data sheets and typical

schematics of both system components and complete systems are also provided. Chapters included are:

- General Requirements;
- Special-purpose Oil Systems;
- General-purpose Oil Systems; and
- Self-acting Gas Seal Support Systems.

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(13) **Standard:** API Std 670
Title: Machinery Protection Systems
Description: This standard covers the minimum requirements for a machinery protection system measuring radial shaft vibration, casing vibration, shaft axial position, shaft rotational speed, piston rod drop, phase reference, over speed, and critical machinery temperatures (such as bearing metal and motor windings). It covers requirements for hardware (transducer and monitor systems), installation, documentation, and testing.

ANSI – American National Standards Institute

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(14) **Standard:** ANSI B1.20.1
Title: Pipe Threads, General Purpose (Inch)
Description: Covers dimensions and gaging of pipe threads for general purpose applications

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(15) **Standard:** ANSI B15.1
Title: Safety Standard for Mechanical Power Transmission Apparatus
Description: The requirements of this Standard apply to any source of hazard to people from the operation of mechanical power transmission apparatus on machines, equipment, or systems that are stationary in their use, other than the point operation. This Standard applies to the sources of mechanical power, and also to pulleys, gears, and other mechanical components used to transmit power to the point of operation. Where other standards take precedence by specific reference to power transmission apparatus, this B15.1 Standard shall not apply. Hazards to people pertain to the rotating, oscillating, reciprocating, transversing, or other motions associated with equipment used in the mechanical transmission of power.

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(16) **Standard:** ANSI B16.5
Title: Pipe Flanges and Flanged Fittings
Description: This standard covers pressure-temperature ratings, materials, dimensions, tolerances, marking, testing, and methods of designating openings for pipe flanges and flanged fittings. Included are:

Flanges with rating class designations 150, 300, 400, 600, 900, 1500 and 2500 in sizes NPS 1/2 through NPS 24 with requirements given in both metric and US Customary Units with diameter of bolts and flange bolt holes expressed in inch units; flanges fittings with rating class designation 150 and 300 in sizes NPS 1/2 through NPS 24 with requirements given in both metric and US Customary Units with diameter of bolts and flanges bolt holes expressed in inch units; flanged fittings with rating class designation 400, 600, 900, 1500, and 2500 in sizes NPS 1/2 through NPS 24 that are acknowledged in a nonmandatory annexure in which only US Customary Units are provided.

This standard is limited to:
Flanges and flanged fittings made from cast or forged materials and Blind flanges and certain reducing flanges made from cast, forged, or plate materials. Also included in this standard are requirements and recommendations regarding flange bolting, flange gaskets and flange joints.

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(17) **Standard:** ANSI B16.9
Title: Factory-Made Wrought Butt welding Fittings
Description: This Standard covers overall dimensions, tolerances, ratings, testing, and markings for wrought carbon and alloy steel factory-made butt welding fittings of NPS 1/2 through 48. It covers fittings of any producible wall thickness. This standard does not cover low pressure corrosion resistant butt welding fittings.

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(18) **Standard:** ANSI B16.11
Title: Forged Steel Fittings, Socket-Welding and Threaded
Description: This Standard covers ratings, dimensions, tolerances, marking and material requirements for forged fittings, both socket-welding and threaded.

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(19) **Standard:** ANSI/ASME B16.20
Title: Metallic Gaskets for Pipe Flanges: Ring-Joint, Spiral-Wound, and Jacketed
Description: This Standard covers materials, dimensions, tolerances, and markings for metal ring-joint gaskets, spiral-wound gaskets and metal-jacketed gaskets. This Standard covers spiral-wound metal gaskets and metal-jacketed gaskets for use with raised-face and flat-face flanges.

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(20) **Standard:** ANSI/ASME B16.25

	Title:	Butt welding Ends
	Description:	This Standard covers the preparation of butt welding ends of piping components to be joined into a piping system by welding. It includes requirements for welding bevels, for external and internal shaping of heavy-wall components, and for preparation of internal ends (including dimensions and tolerances). Coverage includes preparation for joints with the following: no backing rings; split or non-continuous backing rings; solid or continuous backing rings; consumable insert rings; gas tungsten arc welding (GTAW) of the root pass.
(21)	**Standard:**	ANSI B16.34
	Title:	Valves Flanged, Threaded and Welding End
	Description:	This standard applies to new valve construction and covers pressure-temperature ratings, dimensions, tolerances, materials, nondestructive examination requirements, testing, and marking for cast, forged, and fabricated flanged, threaded, and welding end, and wafer or flangeless valves of steel, nickel-base alloys, and other alloys. Wafer or flangeless valves, bolted or through-bolt types, that are installed between flanges or against a flange shall be treated as flanged end valves.
(22)	**Standard:**	ANSI B18.2.2
	Title:	Square and Hex Nuts (Inch Series)
	Description:	This Standard is intended to cover the complete general and dimensional data for the various types of inch series square and hex nuts recognized as “American National Standard.” Also included are appendices covering gaging of slots in slotted nuts, wrench openings for nuts, and formulas on which dimensional data are based. It should be understood, however, that where questions arise concerning acceptance of product, the dimensions in the Tables shall govern over recalculation by formula. The inclusion of dimensional data in this Standard is not intended to imply that all of the products described herein are stock production sizes. Consumers are requested to consult with manufacturers concerning lists of stock production sizes.
(23)	**Standard:**	ANSI B36.10M
	Title:	Welded and Seamless Wrought Steel Pipe
	Description:	This Standard covers the standardization of dimensions of welded and seamless wrought steel pipe for high or low temperatures and pressures. The word pipe is used, as distinguished from tube, to apply to tubular products of dimensions commonly used for pipeline and piping systems.

Pipe NPS 12 (DN 300) and smaller have outside diameters numerically larger than their corresponding sizes. In contrast, the outside diameters of tubes are numerically identical to the size number for all sizes.

ASTM – American Society for Testing and Materials

(24) **Standard:** ASTM A36

Title: Standard Specification for Carbon Structural Steel

Description: This specification covers carbon steel shapes, plates, and bars of structural quality for use in riveted, bolted, or welded construction of bridges and buildings, and for general structural purposes.

ii) Supplementary requirements are provided for use where additional testing or additional restrictions are required by the purchaser. Such requirements apply only when specified in the purchase order.

iii) When the steel is to be welded, a welding procedure suitable for the grade of steel and intended use or service is to be utilized.

vi) For structural products produced from coil and furnished without heat treatment or with stress relieving only, the additional requirements, including additional testing requirements and the reporting of additional test results, of A 6/A 6M apply.

(25) **Standard:** ASTM A123

Title: Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

Description: This specification covers the requirements for zinc coating (galvanizing) by the hot-dip process on iron and steel products made from rolled pressed and forged shapes, castings, plates, bars, and strips.

This specification covers both unfabricated products and fabricated products, for example, assembled steel products, structural steel fabrications, large tubes already bent or welded before galvanizing, and wire work fabricated from uncoated steel wire. This specification also covers steel forgings and iron castings incorporated into pieces fabricated before galvanizing or which are too large to be centrifuged (or otherwise handled to remove excess galvanizing bath metal).

This specification does not apply to wire, pipe, tube, or steel sheet which is galvanized on specialized or continuous lines, or

to steel less than 22 gauge (0.0299 in.) [0.76 mm] thick.

The galvanizing of hardware items that are to be centrifuged or otherwise handled to remove excess zinc (such as bolts and similar threaded fasteners, castings and rolled, pressed and forged items) shall be in accordance with Specification A 153/A 153M.

Fabricated reinforcing steel bar assemblies are covered by the present specification. The galvanizing of separate reinforcing steel bars shall be in accordance with Specification A 767/A 767M.

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(26) **Standard:** ASTM A153

Title: Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware

Description: This specification covers zinc coatings applied by the hot-dip process on iron and steel hardware. The hot-dip galvanizing process consists of parts being immersed in molten zinc for a sufficient time to allow a metallurgical reaction between iron from the steel surface and the molten zinc, resulting in the formation of Zn/Fe alloy layers bonding the coating to the steel surface.

This specification is intended to be applicable to hardware items that are centrifuged or otherwise handled to remove excess galvanizing bath metal (free zinc). Coating thickness grade requirements reflect this.

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(27) **Standard:** ASTM A234

Title: Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service

Description: This specification covers wrought carbon steel and alloy steel fittings of seamless and welded construction covered by the latest revision of ASME B16.9, B16.11, MSS-SP-79, MSS-SP-83, and MSS-SP-95. These fittings are for use in pressure piping and in pressure vessel fabrication for service at moderate and elevated temperatures. Fittings differing from these ASME and MSS standards shall be furnished in accordance with Supplementary Requirement S58 of Specification A 960/A 960M. Optional supplementary requirements are also provided for fittings where a greater degree of examination is desired.

This specification does not cover cast welding fittings or fittings machined from castings. Cast steel welding fittings are governed by Specifications A 216/A 216M and A 217/A 217M.

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(28) **Standard:** ASTM A285

Title: Standard Specification for Pressure Vessel Plates, Carbon Steel, Low- and Intermediate-Tensile Strength

Description: This specification covers carbon steel plates of low- and intermediate-tensile strengths which may be made by killed, semi-killed, capped, or rimmed steel practices. These plates are intended for fusion-welded pressure vessels.

The maximum thickness of plates under this specification, for reasons of internal soundness, is limited to a maximum thickness of 2 in. [50 mm] for all grades.

For plates produced from coil, the additional requirements, including additional testing requirements and the reporting of additional test results, of Specification A20/A20M apply.

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(29) **Standard:** ASTM A515

Title: Standard Specification for Pressure Vessel Plates, Carbon Steel, for Intermediate-, and Higher-Temperature Service

Description: Covers the general requirements that, unless otherwise specified in the product specification, apply to steel sheet in coils & cut lengths, metallic-coated on continuous lines by the hot-dip process.

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(30) **Standard:** ASTM A500

Title: Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes

Description: This specification covers cold-formed welded and seamless carbon steel round, square, rectangular, or special shape structural tubing for welded, riveted, or bolted construction of bridges and buildings, and for general structural purposes.

This tubing is produced in both welded and seamless sizes with a maximum periphery of 64 in. (1626 mm) and a maximum wall of 0.625 in. (15.88 mm). Grade D requires heat treatment.

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(31) **Standard:** ASTM A563

Title: Standard Specification for Carbons and Alloy Steel Nuts

Description: This specification covers chemical and mechanical requirements for eight grades of carbon and alloy steel nuts for general

structural and mechanical uses on bolts, studs, and other externally threaded parts.

The requirements for any grade of nut may, at the supplier's option, and with notice to the purchaser, be fulfilled by furnishing nuts of one of the stronger grades specified herein unless such substitution is barred in the inquiry and purchase order.

Grades C3 and DH3 nuts have atmospheric corrosion resistance and weathering characteristics comparable to that of the steels covered in Specifications A 242/A 242M, A 588/A 588M, and A 709/A 709M. The atmospheric corrosion resistance of these steels is substantially better than that of carbon steel with or without copper addition.

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(32) **Standard:** ASTM A578

Title: Standard Specification for Straight-Beam Ultrasonic Examination of Rolled Steel Plates for Special Applications

Description: This specification covers the procedure and acceptance standards for straight-beam, pulse-echo, ultrasonic examination of rolled carbon and alloy steel plates, ³/8 in. [10 mm] in thickness and over, for special applications. The method will detect internal discontinuities parallel to the rolled surfaces. Three levels of acceptance standards are provided. Supplementary requirements are provided for alternative procedures.

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(33) **Standard:** ASTM E23

Title: Standard Test Methods for Notched Bar Impact Testing of Metallic Materials

Description: These test methods describe notched-bar impact testing of metallic materials by the Charpy (simple-beam) test and the Izod (cantilever-beam) test. They give the requirements for: test specimens, test procedures, test reports, test machines verifying Charpy impact machines, optional test specimen configurations, precracking Charpy V-notch specimens, designation of test specimen orientation, and determining the percent of shear fracture on the surface of broken impact specimens. In addition, information is provided on the significance of notched-bar impact testing, methods of measuring the center of strike.

These test methods do not address the problems associated with impact testing at temperatures below -196 C (-320 F, 77 K).

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(34) **Standard:** ASTM E92

Title: Standard Test Method for Vickers Hardness of Metallic Materials

Description: This test method covers the determination of the Vickers hardness of metallic materials, using applied forces of 1 kgf to 120 kgf, the verification of Vickers hardness testing machines (Part B), and the calibration of standardized hardness test blocks (Part C). Two general classes of standard tests are recognized:

a. Verification, Laboratory, or Referee Tests, where a high degree of accuracy is required.

b. Routine Tests where a somewhat lower degree of accuracy is permissible.

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(35) **Standard:** ASTM E112

Title: Standard Test Methods for Determining Average Grain Size

Description: These test methods cover the measurement of average grain size and include the comparison procedure, the planimetric (or Jeffries) procedure, and the intercept procedures. These test methods may also be applied to nonmetallic materials with structures having appearances similar to those of the metallic structures shown in the comparison charts. These test methods apply chiefly to single phase grain structures but they can be applied to determine the average size of a particular type of grain structure in a multiphase or multi constituent specimen.

These test methods are used to determine the average grain size of specimens with a unimodal distribution of grain areas, diameters, or intercept lengths. These distributions are approximately log normal. These test methods do not cover methods to characterize the nature of these distributions.

These test methods deal only with determination of planar grain size, that is, characterization of the two-dimensional grain sections revealed by the sectioning plane. Determination of spatial grain size, that is, measurement of the size of the three-dimensional grains in the specimen volume, is beyond the scope of these test methods.

These test methods describe techniques performed manually using either a standard series of graded chart images for the comparison method or simple templates for the manual counting methods.

These test methods deal only with the recommended test methods and nothing in them should be construed as defining or

establishing limits of acceptability or fitness of purpose of the materials tested.

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(36) **Standard:** ASTM E350

Title: Standard Test Methods for Chemical Analysis of Carbon Steel, Low-Alloy Steel, Silicon Electrical Steel, Ingot Iron, and Wrought Iron

Description: These test methods cover the chemical analysis of carbon steels, low-alloy steels, silicon electrical steels, ingot iron, and wrought iron having chemical compositions within the stipulated limit.

Test methods for the determination of several elements not included in this standard can be found in Test Methods E 30 and Test Methods E 1019.

Some of the concentration ranges given in are too broad to be covered by a single test method and therefore this standard contains multiple test methods for some elements. The user must select the proper test method by matching the information given in the Scope and Interference sections of each test method with the composition of the alloy to be analyzed.

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(37) **Standard:** ASTM F436

Title: Standard Specification for Hardened Steel Washers

Description: This specification covers the chemical, mechanical, and dimensional requirements for hardened steel washers for use with fasteners having nominal thread diameters of ¼ through 4 in. These washers are intended for general-purpose mechanical and structural use with bolts, nuts, studs, and other internally and externally threaded fasteners.

The washers are designated by type denoting the material and by style denoting the shape.
The types of washers covered are:

a. Carbon steel;
b. Weathering steel.

The styles of washers covered are:

a. Circular – Circular washers in nominal bolt sizes ¼ through 4 in. suitable for applications where sufficient space exists and angularity permits;
b. Beveled – Beveled washers are square or rectangular, in nominal sizes ½ through 1½ in., with a beveled 1 to 6

ratio surface for use with American standard beams and channels;

c. Clipped – Clipped washers are circular or beveled for use where space limitations necessitate that one side be clipped; and

d. Extra Thick – Extra thick washers are circular washers in nominal sizes ½ through 1½ in., with a nominal thickness of 5/16 in. suitable for structural applications with oversized holes.

AGMA – American Gear Manufacturers Association

(38) **Standard:** AGMA 9002-A86

Title: Bores and Keyways for Flexible Couplings (Inch Series)

Description: Provides designers and users standard dimensions and tolerances for inch bores, keys and keyways for flexible couplings. Includes dimensions that represent the dimensions and tolerances used within the industry for pre- engineered couplings, but that can also be used for custom engineered coupling products.

ISO – International Standard Organization

(39) **Standard:** ISO 3661

Title: End-suction centrifugal pumps – Baseplate and installation dimensions

Description: Specifies basic dimensions and gives alternative numbers and locations of baseplate fixing holes to suit individual installations. Covers the baseplate numbers from 2 to 9. The data given are intended primarily for use with pumps in accordance with ISO 2858, coupled to foot-mounted electric motors for installation on a foundation

(40) **Standard:** ISO 8501-2

Title: Preparation of steel substrates before application of paints and related products – Visual assessment of surface cleanliness – Part 2: Preparation grades of previously coated steel substrates after localized removal of previous coatings

Description: Specifies a series of preparation grades for steel surfaces after localized removal of previous paint coatings. Contains photographs showing examples of preparation grades. The various preparation grades are defined by written descriptions. Applicable to surfaces prepared for painting by methods such as blast-cleaning, hand- and power-tool cleaning, and machine abrading.

(41) **Standard:** ISO 9000

Title: Quality management systems – Fundamentals and vocabulary

Description: This International Standard is applicable for:

- organizations seeking advantage through the implementation of a quality management system;
- organizations seeking confidence from their suppliers that their product requirements will be satisfied;
- those concerned with a mutual understanding of the terminology used in quality management (e.g. suppliers, customers, regulators);
- those internal or external to the organization who assess the quality management system or audit it for conformity with the requirements of ISO 9001 (e.g. auditors, regulators, certification/registration bodies);
- those internal or external to the organization who give advice or training on the quality management system appropriate to that organization;
- Developers of related standards.

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(42) **Standard:** ISO 9001

Title: Quality management systems -- Requirements

Description: ISO 9001:2008 specifies requirements for a quality management system where an organization

- needs to demonstrate its ability to consistently provide product that meets customer and applicable statutory and regulatory requirements, and
- aims to enhance customer satisfaction through the effective application of the system, including processes for continual improvement of the system and the assurance of conformity to customer and applicable statutory and regulatory requirements.

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(43) **Standard:** ISO 10434

Title: Bolted bonnet steel gate valves for the petroleum, petrochemical and allied industries

Description: ISO 10434 specifies the requirements for a heavy-duty series of bolted bonnet steel gate valves for petroleum refinery and related applications where corrosion, erosion and other service conditions would indicate a need for full port openings, heavy wall sections and large stem diameters. It sets forth the requirements for the following gate valve features: bolted bonnet; outside screw and yoke; rising stems; nonrising handwheels;

single or double gate; wedge or parallel seating; metallic seating surfaces; flanged or butt-welding ends. It covers valves of the various nominal sizes.

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(44) **Standard:** ISO 14313

Title: Petroleum and natural gas industries - Pipeline transportation systems - Pipeline valves

Description: ISO 14313 specifies requirements and provides recommendations for the design, manufacturing, testing and documentation of ball, check, gate and plug valves for application in pipeline systems meeting the requirements of ISO 13623 for the petroleum and natural gas industries. It is not applicable to subsea pipeline valves, as they are covered by a separate International Standard (ISO 14723).

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(45) **Standard:** ISO 14001

Title: Environmental Management Systems

Description: ISO 14001 specifies requirements for an environmental management system to enable an organization to develop and implement a policy and objectives which take into account legal requirements and other requirements to which the organization subscribes, and information about significant environmental aspects. It applies to those environmental aspects that the organization identifies as those which it can control and those which it can influence. It does not itself state specific environmental performance criteria.

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(46) **Standard:** ISO 14313

Title: Petroleum and natural gas industries - Pipeline transportation systems - Pipeline valves

Description: ISO 14313 specifies requirements and provides recommendations for the design, manufacturing, testing and documentation of ball, check, gate and plug valves for application in pipeline systems. It is not applicable to subsea pipeline valves, as they are covered by a separate International Standard (ISO 14723).

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(47) **Standard:** ISO 21329

Title: Petroleum and natural gas industries - Pipeline transportation systems - Test procedures for mechanical connectors

Description: ISO 21329 specifies requirements and provides guidance for the testing of mechanical connectors for use in pipeline transportation systems for the petroleum and natural gas industries. The tests specified in this standard are intended to

form part of the design verification process for connectors. They provide objective evidence that connectors conform to a defined performance envelope.

BS – British Standards

(48) **Standard:** BS 1414
Title: Specification for steel wedge gate valves (flanged and butt-welding ends) for the petroleum, petrochemical and allied industries
Description: Outside screw and yoke, solid wedge (plain or flexible) rising stem gate valves, with or without soft seals in nominal sizes within the range 25 to 600 mm (l to 24in) and Class 150 to 2500. Covers also carbon steel valves in nominal sizes 650 to 1050 mm (26 to 42 in) in Class 150 and 300 only.

(49) **Standard:** BS 1873
Title: Specification for steel globe and globe stop and check valves (flanged and butt-welding ends) for the petroleum, petrochemical and allied industries
Description: Straight, angle and (oblique) Y pattern with flanged or butt-welding ends in nominal sizes from 15 to 400 mm (½ to 16 in) and Class 150 to 2500.

(50) **Standard:** BS 3799
Title: Specification for steel pipe fittings, screwed and socket-welding for the petroleum industry
Description: Forged carbon and alloy steel screwed and socket-welding fittings. Screw threads in accordance with API Std. 5B. Bore diameters of socket-welding fittings compatible with BS 3600 and BS 1600. Substantially agrees with ANSI B16.11, ASTM A 234 and ASTM A 403.

(51) **Standard:** BS 5154
Title: Specification for copper alloy globe, globe stop and check, check and gate valves
Description: Design, details of body ends, materials, marking and preparation for storage and transportation.

(52) **Standard:** BS 5351
Title: Specification for steel ball valves for the petroleum, petrochemical and allied industries
Description: Valve seat and body pressure/temperature ratings, the design, materials, dimensions, operation, performance, testing and marking of straightway steel ball valves having specified wall

thickness, antistatic feature and fire tested design. Valves of PN 10 to PN 40 and classes 150, 300, 600 and 800 with a variety of end fittings.

(53) **Standard:** BS 6755-1
Title: Testing of Valves – Part 1: Specification for Production Pressure Testing Requirements
Description: Tests to confirm the pressure containing capability of the shell of a valve under pressure, and tests verifying the degree of tightness and pressure-retaining capability of the valve seat(s) and/or closure mechanism.

(54) **Standard:** BS 6755-2
Title: Testing of valves. Specification for fire type-testing requirements
Description: Includes the method of confirming the pressure containing capability of a valve under pressure during and after the fire test.

Cathodic Protection

(55) **Standard:** API RP 651
Title: Cathodic Protection of Aboveground Petroleum Storage Tanks
Description: The purpose of this recommended practice is to present procedures and practices for achieving effective corrosion control on aboveground storage tank bottoms through the use of cathodic protection. It contains provisions for the application of cathodic protection to existing and new storage tanks. Corrosion control methods based on chemical control of the environment or the use of protective coatings are not covered in detail.

(56) **Standard:** NACE Standard MR0175
Title: Sulfide Stress Cracking Resistant Metallic Materials for Oil fields Equipment
Description: This standards presents metallic material requirements for resistance to sulfide stress cracking (SSC) for petroleum production, drilling, gathering and flowline equipment, and field processing facilities to be used in H2S- bearing hydrocarbon service. This standard does not include and is not intended to include design specifications. Other forms of corrosion and other modes of failure, although outside the scope of this standard, should also be considered in design and operation of equipment.

(57) Other related standards:

Standard: API 700
Title: Checklist for Plant Completion

Standard: MSS SP-43
Title: Wrought and Fabricated Butt-Welding Fittings for Low Pressure, Corrosion Resistant Applications

Standard: MSS SP-44
Title: Steel Pipeline Flanges

Standard: MSS SP-55
Title: Quality Standard for Steel Castings for Valves, Flanges and Fittings and Other Piping Components - Visual Method for Evaluation of Surface Irregularities

Standard: MSS SP-75
Title: Specification for High Test Wrought Butt Welding Fittings

Standard: ASTM A307
Title: Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength

Standard: ASTM A370
Title: Standard Test Methods and Definitions for Mechanical Testing of Steel Products

Standard: ASTM A450
Title: Standard Specification for General Requirements for Carbon and Low Alloy Steel Tubes

Standard: ISO 2548
Title: Centrifugal, mixed flow and axial pumps -- Code for acceptance tests -- Class C

Standard: ISO 3555
Title: Centrifugal, mixed flow and axial pumps -- Code for acceptance tests -- Class B

Standard: ISO 5199
Title: Technical specifications for centrifugal pumps -- Class II

Standard: ISO 15590
Title: Petroleum and natural gas industries -- Induction bends, fittings and flanges for pipeline transportation systems

Standard: BS 5352
Title: Specification for Steel Wedge Gate, Globe and Check Valves

50mm and Smaller for the Petroleum, Petrochemical and Allied Industries

Standard: ASNT SNT-TC-1A
Title: Recommended Practice No. SNT-TC-1A - Non-Destructive Testing

Standard: AWS D1.1
Title: Structural Welding Code - Steel

Standard: AWS B1.11
Title: Guide for the Visual Examination of Welds

Standard: AWS D1.2
Title: Structural Welding Code

Standard: AWS A2.4
Title: Standard Symbols for Welding, Brazing, Nondestructive Examination

Standard: AWS B2.1
Title: Specification for Welding Procedure and Performance Qualification

Standard: AS 2508
Title: Safe storage and handling information cards for hazardous materials - Sulfuric acid (up to 98% m/m)

Chapter-13

19. Electrical Systems

(1) **Standard:** NFPA 70
Title: National Electrical Code
Description: This standard describes public safety, emergency preparedness, Code usability, and worker protection. The NEC protects the public by establishing requirements for electrical wiring and equipment in virtually all buildings. It includes the latest rules for electrical installation in residential, commercial, and industrial occupancies. It also introduces:

- Critical Operations Power Systems with provisions for electrical security in public and private facilities that must stay online during a crisis, such as public safety dispatch

centers and hospital ICUs.

- Electrified Truck Parking Spaces with NEC rules for outlets to run on-board electrical systems, reducing truck emissions and fuel consumption caused by idling during driver rest times.

The NEC is a must for electrical contractors, engineers, electricians, fire service professionals, safety officials, inspectors, and architects.

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(2) **Standard:** API RP 540
Title: Electrical Installations in Petroleum Processing Plants
Description: This recommended practice provides information on electrical installations in petroleum processing plants. It is intended for all individuals and organizations concerned with the safe design, installation and operation of electrical facilities in petroleum processing plants.

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(3) **Standard:** BS 5345-8:1980
Title: Code of Practice for Selection, Installation & Maintenance of Electrical Apparatus for Use in Potentially Explosive Atmospheres
Description: Provides guidance on the use of special electrical apparatus which is certified for use in explosive gas atmospheres but which does not conform to any of the standard techniques of protection as specified in existing standards.

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(4) **Standard:** BS 5501-9
Title: Electrical apparatus for potentially explosive atmospheres. Specification for intrinsically safe electrical systems 'i'
Description: Specific requirements for construction and testing of intrinsically safe systems intended for use, as a whole or in part, in potentially explosive atmospheres.

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(5) **Standard:** BS 6346
Title: Electric cables. PVC insulated, armoured cables for voltages of 600/1000 V and 1900/3300 V
Description: Requirements for construction and methods of test for cables for use in fixed installations in industrial areas, buildings and similar applications.

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(6) **Standard:** BS 6360
Title: Specification for conductors in insulated cables and cords
Description: Requirements for aluminum and copper conductors in insulated

wires and cords

(7)	**Standard:**	NEMA MG2
	Title:	Safety Standard for Construction and Guide for Selection, Installation, and Use of Electric Motors and Generators
	Description:	Provides recommendations for the selection, installation, and use of rotating electric machines in such a manner as to provide for the practical safeguarding of persons and property. Companion Standards: MG 1, MG 10

(8) Other related standards:

Switchgear and Control Gear

IEC 60038	IEC standard voltages
IEC 60044-1	Instrument transformers - Part 1: Current transformers
IEC 60044-2	Instrument transformers - Part 2 : Inductive voltage transformers
IEC 60044-5	Instrument transformers - Part 5: Capacitor voltage transformers
IEC 60050	International electro-technical vocabulary
IEC 60051	Direct acting indicating analog electrical measuring instruments and their accessories
IEC 60059	Standard current ratings
IEC 60073	Basic and safety principles for man-machine interface, marking and identification - Coding principles for indicators and actuators
IEC 60079	Electrical apparatus for explosive gas atmospheres
IEC 60112	Methods of determining the comparatives and the proof tracking indices of solid insulating material
IEC 60255	Electrical relays
IEC 60269	Low voltage fuses
IEC 60364	Low-voltage electrical installations
IEC 60439	Low-voltage switchgear and control gear assemblies

IEC 60445	Basic and safety principles for man-machine interface, marking and identification - Identification of equipment terminals and conductor terminations
IEC 60529	Degrees of protection provided by enclosures (IP Code)
IEC 60664	Insulation coordination for equipment within low-voltage systems
IEC 60947-1	Low-voltage switchgear and contro gear - Part 1: General rules
IEC 60947-2	Low-voltage switchgear and control gear - Part 2: Circuit-breakers
IEC 60947-3	Low-voltage switchgear and control gear - Part 3: Switches, disconnectors, switch-disconnectors and fuse-combination units
IEC 60947-4-1	Low-voltage switchgear and control gear - Part 4-1: Contactors and motor-starters - Electromechanical contactors and motor-starters
IEC 60947-5-1	Low-voltage switchgear and control gear - Part 5-1: Control circuit devices and switching elements - Electromechanical control circuit devices
IEC 62271	High-voltage switchgear and control gear

Power Transformer	
IEC 60055	Paper-insulated metal-sheathed cables for rated voltages up to 18/30 kV (with copper or aluminum conductors and excluding gas-pressure and oil-filled cables).
IEC 60071	Insulation coordination
IEC 60076	Power transformers
IEC 60085	Electrical insulation - Thermal evaluation and designation
IEC 60137	Insulated bushings for alternating voltages above 1 000 V
IEC 60141	Tests on oil-filled and gas-pressure cables and their accessories
IEC 60296	Fluids for electrotechnical applications - Unused mineral insulating oils for transformers and switchgear

IEC 60616	Terminal and tapping markings for power transformers
BS 729	Specification for hot-dip galvanized coatings
BS 2757	Thermal classification of electrical insulation

Cables	
IEC 60228	Conductors and insulated cables.
IEC 60332	Tests on electric and optical fibre cables under fire conditions
IEC 60502	Power cables with extruded insulation and their accessories for rated voltages from 1 kV (Um = 1,2 kV) up to 30 kV (Um = 36 kV)
IEC 60800	Heating cables with a rated voltage of 300/500 V for comfort heating and prevention of ice formation
IEC 60811	Common test methods for insulating and sheathing materials of electric cables and optical cables
BS 5467	Specification for Cables with Themosetting Insulation for Electricity Supply for Rated Voltages of up to and Including 600/1000 V and up to and Including 1900/3300 V
BS 6346	Electric cables. PVC insulated, armoured cables for voltages of 600/1000 V and 1900/3300 V
BS 6360	Specification for conductors in insulated cables and cords
BS 6469	Insulating and sheathing materials of electric cables
BS 6480	Specification for impregnated paper-insulated lead or lead alloy sheathed electric cables of rated voltages up to and including 33000 V

Rotating Machines	
IEC 60034	Rotating electrical machines
IEC 60072	Dimensions and output series for rotating electrical machines
BS 2757	Method for determining the thermal classification of electrical insulation
BS 4278	Specification for eye bolts for lifting purposes

BS 4683	Pat 2: Specification for electrical apparatus for explosive atmospheres. The construction and testing of flameproof enclosures of electrical apparatus
BS 4999	General requirements for rotating electrical machines. Specification for symbols
BS 5000	Specification for rotating electrical machines of particular types or for particular applications. Small-power electric motors and generators
BS 5501	Electrical apparatus for potentially explosive atmospheres

Miscellaneous Equipment and Codes of Practice	
IEC 60129	AC Disconnectors and earthing switches
IEC 60282-1	High-voltage fuses - Part 1: Current-limiting fuses
IEC 60383	Insulators for overhead lines with a nominal voltage above 1000 V
IEC 60478	Stabilized power supplies, d.c. output.
IEC 60688	Electrical measuring transducers for converting a.c. electrical quantities to analogue or digital signals
IEC 61260	Electroacoustics - Octave-band and fractional-octave-band filters
IEC 61672-1	Electroacoustics - Sound level meters - Part 1: Specifications
IEC 62305	Protection against lightning
IEEE 515	IEEE Standard for the testing, design, installation and maintenance of electrical resistance heat tracing for industrial applications
BS 4727-2: GROUP 08	Glossary of electrotechnical, power, telecommunication, electronics, lighting and color terms. Terms particular to power engineering. Electric cables
BS 5099	Electric cables. Voltage levels for spark testing
BS 5467	Specification for Cables with Themosetting Insulation for Electricity Supply for Rated Voltages of up to and Including 600/1000 V and up to and Including 1900/3300 V

BS 6121-1	Mechanical cable glands. Armour glands. Requirements and test methods
BS 6121-5	Mechanical cable glands. Code of practice for selection, installation and inspection of cable glands and armour glands
BS 6360	Specification for conductors in insulated cables and cords
BS 6469-99.1	Insulating and sheathing materials of electric cables. Test methods used in the United Kingdom but not specified in BS EN 60811. Non-electrical tests
BS 6724	Electric cables. Thermosetting insulated, armoured cables for voltages of 600/1000 V and 1900/3300 V, having low emission of smoke and corrosive gases when affected by fire
BS 6746	PVC insulation and sheath of electric cables
BS 7361-1	Cathodic protection. Code of practice for land and marine applications
BS 7671	Requirements for electrical installations. IEE Wiring Regulations.
BS 7889	Electric cables. Thermosetting insulated, unarmoured cables for a voltage of 600/1000 V
BS EN 10002-1	Tensile Testing of Metallic Materials - Part 1: Method of Test at Ambient Temperature
BS EN 50262	Cable glands for electrical installations
BS EN 50281-1-2	Electrical apparatus for use in the presence of combustible dust. Electrical apparatus protected by enclosures. Selection, installation and maintenance
BS EN 60079-14	Explosive atmospheres. Electrical installations design, selection and erection
BS EN 60423	Conduit systems for cable management. Outside diameters of conduits for electrical installations and threads for conduits and fittings
BS EN 60529	Specification for degrees of protection provided by enclosures (IP code)

BS EN 60811-1-1	Insulating and sheathing materials of electric cables. Common test methods. General application. Measurement of thickness and overall dimensions. Tests for determining the mechanical properties. Section 1: Measurement of thickness and overall dimensions - Tests for determining the mechanical properties
BS EN 60811-1-2	Insulating and sheathing materials of electric cables. Common test methods. Methods specific to elastomeric compounds. Methods specific to elastomeric compounds. Ozone resistance, hot set and mineral oil immersion tests
ANSI/NEMA MG1	Motors and Generators
NACE RP0169-2002	Control of External Corrosion on Underground or Submerged Metallic Piping Systems
NACE RP0572-2001	Design, installation, operation and maintenance of impressed current deep ground beds
NACE RP0193-93	External cathodic protection of on-grade metallic storage tank bottom

Chapter-14

20. Instrumentation System (Refineries, Storage Terminal, Pipeline Systems)

API- American Petroleum Institute		
(1)	**Standard:**	API RP 551
	Title:	Process Measurement Instrumentation
	Description:	Provides procedures for the installation of the more generally used measuring and control instruments and related accessories
(2)	**Standard:**	API RP 552
	Title:	Transmission Systems
	Description:	Reviews the recommended practices for the installation of electronic and pneumatic measurement and control-signal transmission systems. Transmission systems permit operation of one or more large or small process units from a remote control center
(3)	**Standard:**	API RP 553
	Title:	Refinery Control Valves

Description: This standard provides recommended criteria for the selection, specification and application of piston and diaphragm actuated control valves. It also outlines control valve design considerations, discusses control valve sizing, noise, fugitive emissions, and defines types of commonly used control valves and their actuators.

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(4) **Standard:** API RP 554 Part 1

Title: Process Control Systems: Part 1-Process Control Systems Functions and Functional Specification Development, Second Edition

Description: This edition of API RP 554 has been reorganized and split into three documents in order to better define the processes required to properly scope, specify, select, install, commission, operate, and maintain Process Control Systems. These recommended specifications are made for minimum requirements that can be used as a specification basis.

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(5) **Standard:** API RP 554 Part 2

Title: API Recommended Practice 554, Part 2: Process Control Systems - Process Control System Design,

Description: This recommended practice addresses the processes required to successfully implement process control systems for refinery and petrochemical services. The major topics addressed are listed below.

Part 1. The basic functions that a process control system may need to perform, and recommended methodologies for determining the functional and integration requirements for a particular application.

Part 2. Practices to select and design the installation for hardware and software required to meet the functional and integration requirements.

Part 3. Project organization, skills and management required to execute a process control project and then to own and operate a process control system.

The general scope of the material contained has been expanded to cover general industrial process control topics that are applicable to both refineries and petrochemical facilities

Although the scope has been extended beyond traditional

refining services, the user is cautioned to fully consider the requirements of the particular applications and circumstances that may exist and carefully apply the concepts described in this recommended practice as appropriate.

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(6) **Standard:** API RP 554 Part 3

Title: API Recommended Practice 554, Part 3: Process Control Systems - Project Execution and Process Control System Ownership, First Edition

Description: This recommended practice addresses the processes required to successfully implement process control systems for refinery and petrochemical services. The major topics addressed are listed below.

Part 1. The basic functions that a process control system may need to perform, and recommended methodologies for determining the functional and integration requirements for a particular application.

Part 2. Practices to select and design the installation for hardware and software required to meet the functional and integration requirements.

Part 3. Project organization, skills and management required to execute a process control project and then to own and operate a process control system.

As such, the general scope of the material contained has been expanded to cover general industrial process control topics that are applicable to both refineries and petrochemical facilities

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(7) **Standard:** API RP 555

Title: Recommended Practice for Process Analyzers

Description: Process monitors that measures and transmit information about chemical composition, physical properties, or chemical properties are known as process analyzer systems. Many of these systems were first developed for laboratory analysis. Today they are primarily used as continuous on-line analyzers.

A process monitoring system usually requires a sample conditioning system, a process analyzer, and one or more data output devices. Properly designed systems also require overall considerations as to calibration, utilities, sample disposal, safety, and systems packaging.

Process analyzers measure chemical concentrations or physical or chemical properties that can be used as control variables instead of relying on indirect physical parameters, such as pressure, temperature, and inferred data from computer models. Process analyzer systems can provide a significant economic return when incorporated into process optimization and advanced control loops or when used for product quality control.

This section will address the non-analyzer specific design factors that must be taken into consideration in the design and implementation of all analyzer applications.

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(8) **Standard:** API RP 556
Title: Instrumentation and Control Systems for Fired Heaters and Steam Generators
Description: RP 556 was written to aid in the installation of the more generally used measuring, control, and analytical instruments; transmission systems; and related accessories to achieve safe, continuous, accurate and efficient operation with minimum maintenance. Although the information has been prepared primarily for petroleum refineries, much of it is applicable without change in chemical plants, gasoline plants, and similar installations.

BS – British Standards Institute

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(9) **Standard:** BS 5308-1
Title: Instrumentation cables. Specification for polyethylene insulated cables
Description: Specifies requirements for and dimensions of polyethylene insulated cables in pairs, with or without screens and optionally incorporating single wire armour or lead sheath with single wire armour.

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(10) **Standard:** BS 5308-2
Title: Instrumentation cables. Specification for PVC insulated cables
Description: Specifies requirements for and dimensions of PVC insulated cables in multicore and multipair construction, with or without screens and optionally incorporating single wire armour.

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(11) **Standard:** BS 5750-8
Title: Quality systems. Guide to quality management and quality systems elements for services
Description: Guidance on the quality system elements of organizations that

provide services. It is closely linked with service needs and terminology and will enable management in this field to obtain and provide quality assurance.

ISA - Instrument Society of American Standards

(12) **Standard:** ISA 5.1
Title: Instrumentation Symbols and Identification
Description: Establishes a uniform means of designating instruments and instrumentation systems used for measurement and control. The different needs of various organizations are recognized (where not inconsistent with the objectives of the standard) by providing alternative symbolism methods. A number of options are provided for adding information or simplifying the symbolism, if desired. Includes additional information on symbolism for function blocks, function designations, computer functions, and programmable logic control.

Establishes a uniform means of designating instruments and instrumentation systems used for measurement and control. The different needs of various organizations are recognized (where not inconsistent with the objectives of the standard) by providing alternative symbolism methods. A number of options are provided for adding information or simplifying the symbolism, if desired. Includes additional information on symbolism for function blocks, function designations, computer functions, and programmable logic control.

(13) **Standard:** ISA 51.1
Title: Process Instrumentation Terminology
Description: Provides guidance for vendor/user understanding when referring to product specifications, performance, and operating conditions. It is primarily intended to cover the field of analog measurement and control concepts and makes no effort to develop terminology in the field of digital measurement and control. Includes many specialized terms used in the industrial process industries to describe the use, performance, operating influences, hardware, and product qualification of the instrumentation and instrument systems for measurement, control, or both.

Provides guidance for vendor/user understanding when referring to product specifications, performance, and operating conditions. It is primarily intended to cover the field of analog measurement and control concepts and makes no effort to develop terminology in the field of digital measurement and control. Includes many

specialized terms used in the industrial process industries to describe the use, performance, operating influences, hardware, and product qualification of the instrumentation and instrument systems for measurement, control, or both.

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(14) **Standard:** ISA 71.01
Title: Environmental Conditions for Process Measurement & Control Systems : Temperature & Humidity
Description: Establishes uniform classifications of temperature and humidity conditions for industrial process measurement and control systems. The classes of temperature and humidity conditions stated in this standard are suitable for use in activities related to process instrumentation, including design, manufacturing, sales, installation, test, use, and maintenance. The standard is compatible with IEC Publication 654-1, 1979, Operating Conditions for Industrial Process Measurement and Control Equipment, Part 1: Temperature, Humidity, and Barometric Pressure.

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(15) **Standard:** ISA 71.04
Title: Environmental Conditions for Process Measurement & Control Systems: Airborne Contaminants
Description: Classifies airborne contaminants that may affect process measurement and control instruments. This classification system provides a means of specifying the type and the concentration of airborne contaminants to which a specified instrument may be exposed. This standard is limited to airborne contaminants and biological influences only, covering contamination influences that affect industrial process measurement and control systems.

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(16) **Standard:** ISA 84.01
Title: Application of Safety Instrumented Systems for the Process Industries
Description: Formerly S84.01-1996. Addresses the application of Safety Instrumented Systems (SIS) for the process industries, including electrical, electronic, and programmable electronic technology. This standard follows the Safety Life Cycle presented later. This document is intended for those who are involved with design and manufacture of SIS products, installation, commissioning, and pre-startup acceptance testing, and operation, maintenance, documentation, and testing.

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(17) **Standard:** ISA MC96.1
Title: Temperature Measurement Thermocouples

Description: Covers coding of thermocouple and extension wire; coding of insulated duplex thermocouple extension wires; terminology, limits of error and wire sizes for thermocouples and thermocouple extension wires; temperature EMF tables for thermocouples; plus appendices that cover fabrication, checking procedures, selection, and installation.

IEEE - Institute of Electrical and Electronics Engineers

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(18) **Standard:** IEEE C37.90.1

Title: Standard for Surge Withstand Capabilities (SWC) Tests for Relays and Relay Systems Associated with Electric Power Apparatus

Description: Two types of design tests for relays and relay systems that relate to the immunity of this equipment to repetitive electrical transients are specified. Test generator characteristics, test waveforms, selection of equipment terminals on which tests are to be conducted, test procedures, criteria for acceptance, and documentation of test results are described. This standard has been harmonized with IEC standards where consensus could be reached.

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(19) **Standard:** IEEE 730

Title: IEEE Standard for Software Quality Assurance Plans

Description: The standard specifies the format and content of software quality assurance plans. It meets the IEEE/EIA 12207.1 requirements for such plans. Also see IEEE 730.1 i-e Guide for Software Quality Assurance Planning

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(20) **Standard:** IEEE 828

Title: Standard for Software Configuration Management Plans

Description: The minimum required contents of a Software Configuration Management (SCM) Plan are established via this standard. This standard applies to the entire life cycle of critical software (e.g., where failure would impact safety or cause large financial or social losses). It also applies to non critical software and to software already developed. The application of this standard is not restricted to any form, class, or type of software.

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(21) **Standard:** IEEE 1042

Title: Guide to Software Configuration Management

Description: The application of configuration management (CM) disciplines to the management of software engineering projects is described. For those planning software configuration management (SCM) activities, this guide provides insight into the various factors that

must be considered. For users implementing SCM disciplines, suggestions and detailed examples of plans are provided. An interpretation is given of how ANSI/IEEE Std 828-1983, IEEE Standard for Software Configuration Management Plans, can be used for planning the management of different kinds of computer program development and maintenance activities.

ISO - International Standards Organization

(22) **Standard:** ISO 9000
Title: Quality management systems
Description: This International Standard describes fundamentals of quality management systems, which form the subject of the ISO 9000 family, and defines related applicable terms.

FCI - Fluid Controls Institute

(23) **Standard:** FCI 70-2
Title: Control Valve Seat Leakage / Regulator Seat Leakage Set
Description: This standard establishes six classes of seat leakage for control valves. Also defined are specific test procedures to determine the appropriate class. Included are classes commonly associated with double-port, double-seat or balanced single-port control valves with a piston ring seal or metal-to-metal seats; commercial unbalanced single-port, single-seat and balanced single-port valves with extra tight piston rings or other sealing means and metal-to-metal seats; valves for critical applications where the control valve may be required to be closed, without a blocking valve, for long period of time; and resilient seating control valves with "O" rings or similar gapless seals, among others.

(24) **Standard:** FCI 70-3-2004:
Title: Regulator Seat Leakage
Description: This standard applies to pilot operated and direct acting pressure reducing, pressure relieving (back pressure), differential pressure and temperature regulators. Selection of a leakage class is not restricted as to regulator design, but acceptable values for various commercially available designs are suggested for each class under Section 4. The standard cannot be used as a basis for predicting leakage at conditions other than those specified. This standard is similar to FCI 70-2.

This standard does not apply to pressure regulators as defined in the following standards:

- ANSI Z21.18/CSA 6.3

- ANSI Z21.80/CSA 6.22
- ANSI Z21.78/CSA 6.20

(25) Other related standards

Standard:	API 550
Title:	API 550-1: Installation of Refinery Instruments and Control Systems – Part 1 - Process Instrumentation and Control API 550-2: Manual on Installation of Refinery Instruments and Control Systems – Part 2: Process Stream Analyzers API 550-3: Manual on Installation of Refinery Instruments and Control Systems – Part 3: Fired Heaters and Inert Gas Generators API 550-4: Manual on Installation of Refinery Instruments and Control Systems – Part 4: Steam Generators
Standard:	DIN EN 50012
Title:	Low-voltage Switchgear and Controlgear for Industrial Use; Terminal Marking and Distinctive Number for Auxiliary Contacts of Particular Contactors
Standard:	DIN EN 50014
Title:	Electrical apparatus for potentially explosive atmospheres - General requirements
Standard:	DIN EN 50016
Title:	Electrical apparatus for potentially explosive atmospheres - Pressurized apparatus "p"
Standard:	DIN EN 50018
Title:	Electrical apparatus for potentially explosive atmospheres - Flameproof enclosure "d"
Standard:	DIN EN 50019
Title:	Electrical apparatus for potentially explosive atmospheres - Increased safety "e";
Standard:	IEC 32
Title:	Fire resisting characteristics and tests of electric cables
Standard:	IEC 79
Title:	Electrical apparatus for explosive gas atmosphere

Standard: IEC 529
Title: Degrees of protection for electrical and electronic equipment enclosures

Standard: IEC 801,2,3,4
Title: Electromagnetic interference/ susceptibility

Standard: IEC 1131-3
Title: International standard for programmable controllers

Standard: IEC 61158-2
Title: Foundation field bus standard for use in industrial control system

Standard: NEMA 250
Title: Enclosures for Electrical Equipment (1000 Volts Maximum)

Standard: BS 6121-5
Title: Mechanical cable glands. Code of practice for selection, installation and inspection of cable glands and armour glands

Standard: BS 6346
Title: Electric cables. PVC insulated, armoured cables for voltages of 600/1000 V and 1900/3300 V

Standard: BS 7738-1
Title: Specification for information systems products using SSADM (Structured Systems Analysis and Design Method). Implementation of SSADM

Standard: EIA CMB4-1A
Title: Configuration Management Definitions for Digital Computer Programs

Standard: EIA CMB4-2
Title: Configuration Identification for Digital Computer Programs

Standard: EIA CMB4-4
Title: Configuration Change Control, Digital Computer Programs

Standard: AECL CE-1001-STD
Title: Standard for Software Engineering of Safety Critical Software

Standard: EIA CMB6-3

Title:	Configuration Identification
Standard:	EIA CMB7-1
Title:	Electronic Interchange of Configuration Management Data
Standard:	EIA 649-A
Title:	National Consensus Standard for Configuration Management
Standard:	ESA PSS-05-09
Title:	Guide to Software Configuration
Standard:	ISO/IEC 12207
Title:	Information technology - Software life cycle processes
Standard:	BS ISO/IEC TR 15271
Title:	Information technology. Guide for ISO/IEC 12207
Standard:	BS ISO/IEC TR 15846
Title:	Information technology. Software life cycle processes. Configuration management
Standard:	IEEE 1042
Title:	IEEE Guide to Software Configuration Management

Chapter-15

21. Civil/ Structural

(1)	**Standard:**	ASTM A184
	Title:	Standard Specification for Fabricated Deformed Steel Bar Mats for Concrete Reinforcement
	Description:	This specification covers material in mat (or sheet) form fabricated from deformed steel bars to be used for the reinforcement of concrete. Mats consist of two layers of bars that are assembled at right angles to each other. Mats are assembled by welding at the intersections.
(2)	**Standard:**	ASTM A185
	Title:	Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete
	Description:	This specification covers welded wire reinforcement to be used for the reinforcement of concrete. Welded wire for concrete reinforcement has been described by various terms: welded wire fabric, WWF, fabric, and mesh.

(3)	**Standard:**	ASTM A497
	Title:	Standard Specification for Steel Welded Wire Reinforcement, Deformed, for Concrete
	Description:	This specification covers welded wire reinforcement made from cold-worked drawn or rolled deformed wire, or a combination of deformed and non-deformed wires, to be used for the reinforcement of concrete.
(4)	**Standard:**	ASTM A615
	Title:	Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
	Description:	This specification covers deformed and plain carbon-steel bars for concrete reinforcement in cut lengths and coils. Steel bars containing alloy additions, such as with the American Iron and Steel Institute and the Society of Automotive Engineers series of alloy steels, are permitted if the resulting product meets all the other requirements of this specification. Bars are of three minimum yield strength levels: namely, 40 000 psi [280 MPa], 60 000 psi [420 MPa], and 75 000 psi [520 MPa], designated as Grade 40 [280], Grade 60 [420], and Grade 75 [520], respectively.
(5)	**Standard:**	ASTM A775
	Title:	Standard Specification for Epoxy-Coated Steel Reinforcing Bars
	Description:	This specification covers deformed and plain steel reinforcing bars with protective epoxy coating applied by the electrostatic spray method. The coating applicator is identified throughout this specification as the manufacturer. Other organic coatings may be used provided they meet the requirements of this specification.
(6)	**Standard:**	ASTM C29
	Title:	Standard Test Method for Bulk Density ("Unit Weight") and Voids in Aggregate
	Description:	This test method covers the determination of bulk density ("unit weight") of aggregate in a compacted or loose condition, and calculated voids between particles in fine, coarse, or mixed aggregates based on the same determination. This test method is applicable to aggregates not exceeding 125 mm [5 in.] in nominal maximum size.
(7)	**Standard:**	ASTM C33
	Title:	Standard Specification for Concrete Aggregates

Description: This specification defines the requirements for grading and quality of fine and coarse aggregate (other than lightweight or heavyweight aggregate) for use in concrete. It is for use by a contractor, concrete supplier, or other purchaser as part of the purchase document describing the material to be furnished.

This specification is regarded as adequate to ensure satisfactory materials for most concrete. It is recognized that, for certain work or in certain regions, it may be either more or less restrictive than needed. For example, where aesthetics are important, more restrictive limits may be considered regarding impurities that would stain the concrete surface. The specifier should ascertain that aggregates specified are or can be made available in the area of the work, with regard to grading, physical, or chemical properties, or combination thereof.

This specification is also for use in project specifications to define the quality of aggregate, the nominal maximum size of the aggregate, and other specific grading requirements. Those responsible for selecting the proportions for the concrete mixture shall have the responsibility of determining the proportions of fine and coarse aggregate and the addition of blending aggregate sizes if required or approved.

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(8) **Standard:** ASTM C56

Title: Standard Specification for Structural Clay Nonloadbearing Tile

Description: This specification covers structural clay nonloadbearing tile (partition, fireproofing, and furring). One grade of tile is covered, designated Grade NB. The property requirements of this standard apply at the time of purchase. The use of results from testing of tile extracted from masonry structures for determining conformance or non-conformance to the property requirements of this standard is beyond the scope of this standard.

Tile covered by this standard are manufactured from clay, shale, or similar naturally occurring substances and subjected to a heat treatment at elevated temperatures (firing). The heat treatment must develop sufficient fired bond between the particulate constituents to provide the strength and durability requirements of this specification.

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(9) **Standard:** ASTM C62

Title: Standard Specification for Building Brick (Solid Masonry Units Made From Clay or Shale)

Description: This specification covers brick intended for both structural and nonstructural masonry where external appearance is not a requirement. The brick are prismatic units available in a variety of sizes, shapes, textures, and colors.

Brick are manufactured from clay, shale, or similar naturally occurring earthy substances and subjected to a heat treatment at elevated temperatures (firing). The heat treatment must develop sufficient fired bond between the particulate constituents to provide the strength and durability requirements of this specification.

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(10) **Standard:** ASTM C67

Title: Standard Test Methods for Sampling and Testing Brick and Structural Clay Tile

Description: These test methods cover procedures for the sampling and testing of brick and structural clay tile. Although not necessarily applicable to all types of units, tests include modulus of rupture, compressive strength, absorption, saturation coefficient, effect of freezing and thawing, efflorescence, initial rate of absorption and determination of weight, size, warpage, length change, and void area.

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(11) **Standard:** ASTM C73

Title: Standard Specification for Calcium Silicate Brick (Sand-Lime Brick)

Description: This specification covers brick made principally from sand and lime and intended for use in brick masonry. Two grades of brick are covered:

1. Grade SW - Brick intended for use where exposed to temperature below freezing in the presence of moisture.
2. Grade MW - Brick intended for use where exposed to temperature below freezing but unlikely to be saturated with water.

When the term brick is used in this specification, it is understood to mean brick or solid masonry units. If brick having a particular color, texture, finish, or uniformity is desired, these features shall be specified separately.

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(12) **Standard:** ASTM C87

Title: Standard Test Method for Effect of Organic Impurities in Fine Aggregate on Strength of Mortar

Description: This test method covers the determination of the effect on mortar

strength of the organic impurities in fine aggregate. Comparison is made between compressive strengths of mortar made with washed and unwashed fine aggregate.

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(13) **Standard:** ASTM C88

Title: Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate

Description: This test method covers the testing of aggregates to estimate their soundness when subjected to weathering action in concrete or other applications. This is accomplished by repeated immersion in saturated solutions of sodium or magnesium sulfate followed by oven drying to partially or completely dehydrate the salt precipitated in permeable pore spaces. The internal expansive force, derived from the rehydration of the salt upon re-immersion, simulates the expansion of water on freezing. This test method furnishes information helpful in judging the soundness of aggregates when adequate information is not available from service records of the material exposed to actual weathering conditions.

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(14) **Standard:** ASTM C117

Title: Standard Test Method for Materials Finer than 75µm (No. 200) Sieve in Mineral Aggregates by Washing

Description: This test method covers the determination of the amount of material finer than a 75-µm (No. 200) sieve in aggregate by washing. Clay particles and other aggregate particles that are dispersed by the wash water, as well as water-soluble materials, will be removed from the aggregate during the test.

Two procedures are included, one using only water for the washing operation, and the other including a wetting agent to assist the loosening of the material finer than the 75-µm (No. 200) sieve from the coarser material.

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(15) **Standard:** ASTM C136

Title: Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates

Description: This test method covers the determination of the particle size distribution of fine and coarse aggregates by sieving. Some specifications for aggregates which reference this test method contain grading requirements including both coarse and fine fractions. Instructions are included for sieve analysis of such aggregates.

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(16) **Standard:** ASTM C143
Title: Standard Test Method for Slump of Hydraulic-Cement Concrete
Description: This test method covers determination of slump of hydraulic-cement concrete, both in the laboratory and in the field. This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

(17) **Standard:** ASTM C156
Title: Standard Test Method for Water Retention by Liquid Membrane-Forming Curing Compounds for Concrete
Description: This test method covers laboratory determination of the efficiency of liquid membrane-forming compounds for curing concrete, as measured by their ability to reduce moisture loss during the early hardening period.

(18) **Standard:** ASTM C163
Title: Standard Practice for Mixing Thermal Insulating Cement Samples
Description: This practice covers mixing thermal insulating cement samples with water in the preparation of specimens for use in all tests on the cement.

(19) **Standard:** ASTM C171
Title: Standard Specification for Sheet Materials for Curing Concrete
Description: This specification covers materials in sheet form used for covering the surfaces of hydraulic cement concrete to inhibit moisture loss during the curing period and, in the case of the white reflective type materials, to also reduce temperature rise in concrete exposed to radiation from the sun. The following types are included:

i. Curing Paper.
ii. Regular.
iii. White.
iv. Polyethylene Film:
v. Clear.
vi. White Opaque.
vii. White-Burlap-Polyethylene Sheet

(20) **Standard:** ASTM C172
Title: Standard Practice for Sampling Freshly Mixed Concrete
Description: This practice covers procedures for obtaining representative

samples of fresh concrete as delivered to the project site on which tests are to be performed to determine compliance with quality requirements of the specifications under which the concrete is furnished. The practice includes sampling from stationary, paving and truck mixers, and from agitating and nonagitating equipment used to transport central-mixed concrete.

This practice also covers the procedures to be used for preparing a sample of concrete for further testing where it is desirable or necessary to remove the aggregate larger than a designated size.

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(21) **Standard:** ASTM C216

Title: Standard Specification for Facing Brick (Solid Masonry Units Made from Clay or Shale)

Description: This specification covers brick intended for use in masonry and supplying structural or facing components, or both, to the structure. The property requirements of this specification apply at the time of purchase.

The brick are prismatic units available in a variety of sizes, textures, colors, and shapes. This specification is not intended to provide specifications for paving brick.

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(22) **Standard:** ASTM C270

Title: Standard Specification for Mortar for Unit Masonry

Description: This specification covers mortars for use in the construction of non-reinforced and reinforced unit masonry structures. Four types of mortar are covered in each of two alternative specifications: (1) proportion specifications and (2) property specifications.

When the property specification is used to qualify masonry mortars, the testing agency performing the test methods should be evaluated in accordance with Practice C 1093.

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(23) **Standard:** ASTM C289

Title: Standard Test Method for Potential Alkali-Silica Reactivity of Aggregates (Chemical Method)

Description: This test method covers chemical determination of the potential reactivity of an aggregate with alkalies in portland-cement concrete as indicated by the amount of reaction during 24 h at 80 °C between 1 N sodium hydroxide solution and aggregate that has been crushed and sieved to pass a 300-m sieve and be

retained on a 150-m sieve.

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(24) **Standard:** ASTM C476
Title: Standard Specification for Grout for Masonry
Description: This specification covers two types of grout, fine and coarse grout, for use in the construction of masonry structures. Grout is specified by (1) proportions or (2) strength requirements.

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(25) **Standard:** ASTM C482
Title: Standard Test Method for Bond Strength of Ceramic Tile to Portland Cement Paste
Description: This test method covers the determination of the ability of glazed ceramic wall tile, ceramic mosaic tile, quarry tile, and pavers to be bonded to portland cement. This test method includes both face-mounted and back-mounted tile.

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(26) **Standard:** ASTM C648
Title: Standard Test Method for Breaking Strength of Ceramic Tile
Description: This test method covers the determination of the breaking strength of glazed ceramic wall tile, ceramic mosaic tile, quarry tile, and paver tile, having a facial area of at least 1 in.2 (6.4 cm^2).

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(27) **Standard:** ASTM C650
Title: Standard Test Method for Resistance of Ceramic Tile to Chemical Substances
Description: This test method covers a procedure for determining whether, and to what degree, ceramic tiles are affected by prolonged exposure to chemical substances that are commonly used in the household or for cleaning purposes as well as other more severe conditions.

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(28) **Standard:** ASTM C652
Title: Standard Specification for Hollow Brick (Hollow Masonry Units Made From Clay or Shale)
Description: This specification covers hollow building brick and hollow facing brick made from clay, shale, fire clay, or mixtures thereof, and fired to incipient fusion. Four types of hollow brick in each of two grades and two classes are covered. In this specification the term hollow brick shall be understood to mean hollow clay masonry units whose net cross-sectional area (solid area) in any plane parallel to the surface, containing the cores, cells, or deep frogs, is less than 75 % of its gross cross-sectional area measured in the same plane. This specification does not cover

brick intended for use as paving brick.

(29)	**Standard:**	ASTM D75
	Title:	Standard Practice for Sampling Aggregates
	Description:	This practice covers sampling of coarse and fine aggregates for the following purposes: a. Preliminary investigation of the potential source of supply, b. Control of the product at the source of supply, c. Control of the operations at the site of use, and d. Acceptance or rejection of the materials.
(30)	**Standard:**	ASTM D994
	Title:	Standard Specification for Preformed Expansion Joint Filler for Concrete (Bituminous Type)
	Description:	This specification covers bituminous preformed expansion joint filler for use in concrete construction.
(31)	**Standard:**	ASTM D1190
	Title:	Standard Specification for Concrete Joint Sealer, Hot-Applied Elastic Type
	Description:	This specification covers fibrous glass insulation used as a thermal & sound absorbing liner for interior surfaces of ducts, plenums, & other air handling equipment that handle air up to 250 ^{o}F (121 ^{o}C).
(32)	**Standard:**	ASTM D1751
	Title:	Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Non extruding and Resilient Bituminous Types)
	Description:	This specification covers preformed expansion joint filler having relatively little extrusion and substantial recovery after release from compression.
(33)	**Standard:**	ASTM D1883
	Title:	Standard Test Method for CBR (California Bearing Ratio) of Laboratory-Compacted Soils
	Description:	This test method covers the determination of the CBR (California Bearing Ratio) of pavement subgrade, subbase, and base course materials from laboratory compacted specimens. The test method is primarily intended for (but not limited to) evaluating the strength of materials having maximum particle sizes less than 3/4 in. (19 mm). When materials having maximum particle sizes greater than 3/4

in. (19 mm) are to be tested, this test method provides for modifying the gradation of the material so that the material used for tests all passes the 3/ 4-in. sieve while the total gravel (+No. 4 to 3 in.) fraction remains the same. While traditionally this method of specimen preparation has been used to avoid the error inherent in testing materials containing large particles in the CBR test apparatus, the modified material may have significantly different strength properties than the original material. However, a large experience base has developed using this test method for materials for which the gradation has been modified, and satisfactory design methods are in use based on the results of tests using this procedure.

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(34) **Standard:** ASTM D2859

Title: Standard Test Method for Ignition Characteristics of Finished Textile Floor Covering Materials

Description: This fire-test-response standard describes a test method for the determination of the flammability of finished textile floor covering materials when exposed to an ignition source under controlled laboratory conditions.

This test method is applicable to all types of textile floor coverings, regardless of the method of fabrication or whether they are made from natural or man-made fibers. It is possible to apply this test method to unfinished material; however, the results of such a test shall not be considered a satisfactory evaluation of a textile floor covering material for ultimate consumer use.

This standard is used to measure and describe the response of materials, products, or assemblies to heat and flame under controlled conditions, but does not by itself incorporate all factors required for fire hazard or fire risk assessment of the materials, products, or assemblies under actual fire conditions

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(35) **Standard:** ASTM D3564

Title: Standard Practice for Application of Floor Polishes to Maintain Vinyl Composition Tile or Flooring

Description: This practice covers the application of floor polishes to maintain vinyl composition tile or flooring. Floor polishes are applied to vinyl composition tile floors for protection and beautification of the floor surface. Cleaning, polish application, removal, and maintenance procedures are important functions in this process.

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(36) **Standard:** ASTM D4429

Title: Standard Test Method for CBR (California Bearing Ratio) of Soils in Place

Description: This test method covers the determination of the California Bearing Ratio (CBR) of soil tested in place by comparing the penetration load of the soil to that of a standard material. This test method covers the evaluation of the relative quality of subgrade soils, but is applicable to subbase and some base-course materials. This test method is designed to test in-situ materials and corresponds to Test Method D 1883.

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(37) **Standard:** ASTM E84

Title: Standard Test Method for Surface Burning Characteristics of Building Materials

Description: This fire-test-response standard for the comparative surface burning behavior of building materials is applicable to exposed surfaces such as walls and ceilings. The test is conducted with the specimen in the ceiling position with the surface to be evaluated exposed face down to the ignition source. The material, product, or assembly shall be capable of being mounted in the test position during the test. Thus, the specimen shall either be self-supporting by its own structural quality, held in place by added supports along the test surface, or secured from the back side.

The purpose of this test method is to determine the relative burning behavior of the material by observing the flame spread along the specimen. Flame spread and smoke developed index are reported. However, there is not necessarily a relationship between these two measurements.

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(38) **Standard:** ASTM F510

Title: Standard Test Method for Resistance to Abrasion of Resilient Floor Coverings Using an Abrader with a Grit Feed Method

Description: This test method covers the laboratory procedure for determining the abrasion resistance of resilient flooring using an abrader with a grit feeder. The equipment used in this test method is a modification of the Taber abraser. The regular ceramic wheels are replaced by leather clad brass rollers. A grit-feeding device feeds 240-mesh aluminum oxide grit onto the specimen before it passes under the leather clad rollers. Using the exhaust system incorporated in the apparatus, the used grit and abraded material are continuously removed after passing under both rollers.

BSI – British Standards Institutions		
(39)	**Standard:**	BS 459
	Title:	Specification for match boarded wooden door leaves for external use.
	Description:	Size limitations, materials, workmanship and construction for ledged and braced doors, framed and ledged doors and framed, ledged and braced doors for external use.
(40)	**Standard:**	BS 882
	Title:	Specification for aggregates from natural sources for concrete
	Description:	Specifies quality and grading requirements for aggregates obtained by processing natural materials.
(41)	**Standard:**	BS 952-2
	Title:	Glass for glazing. Terminology for work on glass
	Description:	Illustrated definitions of terms related to the cutting, obscuring, silvering, gilding, staining and bending of glass for building purposes.
(42)	**Standard:**	BS 1186-2
	Title:	Timber for and workmanship in joinery. Specification for workmanship
	Description:	Requirements for the fit of parts in various details of joinery.
(43)	**Standard:**	BS 1204
	Title:	Specification for type MR phenolic and aminoplastic synthetic resin adhesives for wood
	Description:	Specification and methods of test for close-contact and gap-filling adhesives used for the manufacture of non-structural wooden assemblies. Covers a grade of adhesive that is not covered in BS EN 204 and BS EN 205 or BS EN 301 and BS EN 302:Parts 1 to 4.
(44)	**Standard:**	BS 1369-1
	Title:	Steel lathing for internal plastering and external rendering. Specification for expanded metal and ribbed lathing
	Description:	Steel type designations, dimensions and tolerances for steel lathing for internal plastering and external rendering.
(45)	**Standard:**	BS 1494-1
	Title:	Specification for fixing accessories for building purposes. Fixings for sheet, roof and wall coverings
	Description:	Hook bolts, nuts; drive screws; washers; self-tapping screws; roofing bolts, nuts, clips; roofing screws; sheeting clips. Materials

(steel and aluminium), dimensions.

(46)	**Standard:**	BS 1567
	Title:	Specification for wood door frames and linings
	Description:	For external doors opening inwards and outwards, and for internal door frames and linings. For frames with wing lights the window portion is required to comply with BS 644-1. Frames for fire check doors are excluded (BS 459:Part 3). Construction, priming.
(47)	**Standard:**	BS 1881-209
	Title:	Testing concrete. Recommendations for the measurement of dynamic modulus of elasticity
	Description:	Procedure for determining dynamic modulus using longitudinal vibration of laboratory specimens.
(48)	**Standard:**	BS 3148
	Title:	Methods of test for water for making concrete (including notes on the suitability of the water)
	Description:	Describes 2 methods. The tests do not give information regarding the long-term durability of concrete and an appendix summarizes present knowledge in the light of which waters may be judged for their suitability for this purpose.
(49)	**Standard:**	BS 4449
	Title:	Steel for the reinforcement of concrete. Weldable reinforcing steel. Bar, coil and decoiled product. Specification
	Description:	BS 4449 is intended for manufacturers, fabricators and purchasers of ribbed reinforcing steel (bars, coils and decoiled products) for the reinforcement of concrete structures. It provides designations based on the grade of steel, the product form and dimensions. The standard is used to specify all normal technical requirements for reinforcing steels, including chemical analysis, mechanical properties, rib geometry and tolerances on dimensions.
(50)	**Standard:**	BS 5051-1
	Title:	Bullet-resistant glazing. Specification for glazing for interior use
	Description:	Performance requirements and procedures for type testing for glazing resistant to five levels of attack by hand-held guns firing bullets and one level of attack by shotgun. For use at temperatures between 10℃ and 30℃. Essential infor mation for installation is also given.

(51)	**Standard:**	BS 5262
	Title:	Code of practice for external renderings
	Description:	Materials, aspects of design, mixes and methods of application of cement-based renderings to all common types of new and old backgrounds. Includes advice on the inspection and repair of defective renderings.
(52)	**Standard:**	BS 5492
	Title:	Code of practice for internal plastering
	Description:	Recommendations for 'wet' plastering using gypsum plasters, lime/gypsum plasters, premixed lightweight plasters and cement based plasters. Suitable plastering systems for all types of background are given, also plasterwork defects and their remedies. A section on fibrous plasterwork is included.
(53)	**Standard:**	BS 5606
	Title:	Guide to accuracy in building
	Description:	To assist in the avoidance or resolving of problems of inaccuracy or fit, the assessment of the likely achievement of specified tolerances, and the monitoring and controlling of work during construction to ensure compliance with specified accuracy.
(54)	**Standard:**	BS 6031
	Title:	Code of practice for earthworks
	Description:	Applies to earthworks forming part of general civil engineering construction such as highways, railways and airfields; bulk excavation for major structures and excavations in pit shafts and trenches for pipelines and drainage works.
(55)	**Standard:**	BS 8110-2
	Title:	Structural use of concrete. Code of practice for special circumstances
	Description:	Deals with situations not specifically described in Part 1. Gives guidance on ultimate limit state calculations and the derivation of partial factors of safety; serviceability calculations, with emphasis on deflections under loading and on cracking.

ACI – American Concrete Institute

(56)	**Standard:**	ACI 301
	Title:	Specifications for Structural Concrete for Buildings
	Description:	This specification is a Reference Specification that the Engineer or Architect can make applicable to any construction project by citing it in the Project Specifications. The Architect/Engineer supplements the provisions of this Reference Specification as

needed by designating or specifying individual project requirements.

The document covers materials and proportioning of concrete; reinforcing and prestressing steels; production, placing, finishing, and curing of concrete; and formwork design and construction. Methods of treatment of joints and embedded items, repair of surface defects, and finishing of formed and unformed surfaces are specified.

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(57) **Standard:** ACI 302.1R

Title: Guide for Concrete Floor and Slab Construction

Description: The quality of a concrete floor or slab is highly dependent on achieving a hard and durable surface that is flat, relatively free of cracks, and at the proper grade and elevation. Properties of the surface are determined by the mixture proportions and the quality of the concreting and jointing operations. The timing of concreting operations, especially finishing, jointing, and curing, is critical. Failure to address this issue can contribute to undesirable characteristics in the wearing surface such as cracking, low resistance to wear, dusting, scaling, high or low spots, poor drainage, and increasing the potential for curling. Concrete floor slabs employing portland cement, regardless of slump, will start to experience a reduction in volume as soon as they are placed. This phenomenon will continue as long as any water, heat, or both, is being released to the surroundings. Moreover, because the drying and cooling rates at the top and bottom of the slab will never be the same, the shrinkage will vary throughout the depth, causing the as-cast shape to be distorted and reduced in volume.

This guide contains recommendations for controlling random cracking and edge curling caused by the concrete's normal volume change. Application of present technology permits only a reduction in cracking and curling, not elimination. Even with the best floor designs and proper construction, it is unrealistic to expect crack-free and curl-free floors. Consequently, every owner should be advised by both the designer and contractor that it is normal to expect some amount of cracking and curling on every project, and that such occurrence does not necessarily reflect adversely on either the adequacy of the floor's design or the quality of its construction.

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(58) **Standard:** ACI 305.1

Title: Specification for Hot Weather Concreting

Description: This specification provides requirements for hot weather concreting that the Architect/ Engineer can make applicable to any construction project by citing it in project specifications. It is intended that the Architect/Engineer use the checklists included in this specification to customize the project specification. The document includes hot weather requirements for production preparations, delivery, placement, finishing, bleed-water evaporation, curing, and protection of concrete. Provisions governing a preplacement conference, concrete mixture proportions, maximum allowable concrete temperature, measurement of the rate of surface evaporation, evaporation control measures, and acceptance of a concrete mixture from past field experience or preconstruction testing are included.

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(59) **Standard:** ACI 318

Title: Building Code Requirements for Structural Concrete and Commentary

Description: The "Building Code Requirements for Structural Concrete" ("Code") covers the materials, design, and construction of structural concrete used in buildings and where applicable in non-building structures. The Code also covers the strength evaluation of existing concrete structures.

Among the subjects covered are: drawings and specifications; inspection; materials; durability requirements; concrete quality, mixing, and placing; formwork; embedded pipes; construction joints; reinforcement details; analysis and design; strength and serviceability; flexural and axial loads; shear and torsion; development and splices of reinforcement; slab systems; walls; footings; pre-cast concrete; composite flexural members; pre-stressed concrete; shells and folded plate members; strength evaluation of existing structures; provisions for seismic design; structural plain concrete; strut-and-tie modeling in Appendix A; alternative design provisions in Appendix B; alternative load and strength reduction factors in Appendix C; and anchoring to concrete in Appendix D.

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(60) **Standard:** ACI 347

Title: Guide to Formwork for Concrete

Description: Objectives of safety, quality, and economy are given priority in these guidelines for formwork. A section on contract documents explains the kind and amount of specification guidance the

engineer/architect should provide for the contractor. The remainder of the report advised the formwork engineer/contractor on the best ways to meet the specification requirements safely and economically. It deals with design, construction, and materials for formwork. Considerations peculiar to architectural concrete are also outlined in a separate chapter. Other sections are devoted to formwork for bridges, shells, mass concrete, and underground work. The concluding chapter on formwork for special methods of construction includes slipforming, preplaced-aggregate concrete, tremie concrete, precast, and prestressed concrete.

American Society of Civil Engineers

(61) **Standard:** ASCE 7
Title: Minimum Design Loads for Buildings and Other Structures
Description: ASCE 7 Standard provides requirements for general structural design and includes means for determining dead, live, soil, flood, wind, snow, rain, atmospheric ice, and earthquake loads, and their combinations that are suitable for inclusion in building codes and other documents.

(62) Other related standards:

Standard: ASTM C57
Title: Specification for Structural Clay Floor Tile

Standard: ASTM C404
Title: Standard Specification for Aggregates for Masonry Grout

Standard: ASTM C494
Title: Standard Specification for Chemical Admixtures for Concrete

Standard: ASTM D698
Title: Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12 400 ft-lbf/ft3 (600 kN-m/m3))

Standard: ASTM D1664
Title: Standard Test Method for Coating and Stripping of Bitumen-Aggregate Mixtures

Standard: ASTM F141
Title: Standard Terminology Relating to Resilient Floor Coverings

Standard: BS 12

Title: Specification for Portland Cement

Standard: BS 146
Title: Specification for blastfurnace cements with strength properties outside the scope of BS EN 197-1

Standard: BS 410-2
Title: Test sieves. Technical requirements and testing. Test sieves of perforated metal plate

Standard: BS 812-104
Title: Testing aggregates. Method for qualitative and quantitative petrographic examination of aggregates

Standard: BS 1202
Title: BS 1202-1:
Specification for nails. Steel nails
BS 1202-2:
Specification for nails. Copper nails
BS 1202-3:
Specification for nails. Aluminum nails

Standard: BS 1203
Title: Hot-setting phenolic and aminoplastic wood adhesives. Classification and test method

Standard: BS 1282
Title: Wood preservatives. Guidance on choice, use and application

Standard: BS 1377-1
Title: Methods of test for soils for civil engineering purposes. General requirements and sample preparation

Standard: BS 4466
Title: Specification for Scheduling, Dimensioning, Bending & Cutting of Steel Reinforcement for Concrete

Standard: BS 4482
Title: Steel wire for the reinforcement of concrete products. Specification

Standard: BS 4483
Title: Steel fabric for the reinforcement of concrete. Specification

Standard:	BS 5328-1
Title:	Concrete - Part 1: Guide to Classifying Concrete
Standard:	BS 5442-1
Title:	Classification of adhesives for construction. Classification of adhesives for use with flooring materials
Standard:	BS 5975
Title:	Code of practice for falsework
Standard:	BS 8110-1
Title:	Structural use of concrete. Code of practice for design and construction
Standard:	BS 8110-3
Title:	Structural use of concrete. Design charts for singly reinforced beams, doubly reinforced beams and rectangular columns
Standard:	ACI 304
Title:	ACI 304 consists of following documents: • 304R-00: Guide for Measuring, Mixing, Transporting & Placing Concrete; • 304.1R-92: Guide for the Use of Preplaced Aggregate Concrete for Structural & Mass Concrete Applications; • 304.2R-96: Placing Concrete by Pumping Methods; • 304.3R-96: Heavyweight Concrete: Measuring, Mixing, Transporting & Placing ; • 304.5R-91: Batching, Mixing & Job Control of Lightweight Concrete; and • 304.6R-91: Guide for the Use of Volumetric Measuring & Continuous Mixing Concrete Equipment.
Standard:	ACI 315
Title:	Detail and Detailing of Concrete Reinforcement

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